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TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

IN the considerably shorter report which has come this year from the Advisory Council on Scientific Policy*, the question discussed at greatest length is that of the present arrangements for education in technology. We are not, indeed, given the separate report dealing with questions arising out of the Percy Report on Higher Technological Education which the Advisory Council promised in its first report in 1948 to prepare; but the Council reiterates its opinion that the effective and speedy application of the results of scientific research is even more urgently required for the promotion of the economic recovery of Great Britain than the furtherance of research itself, and is likely to achieve much quicker results.

The Council has been concerned more particularly with higher education in applied science suitable for men capable of holding positions of the highest responsibility in industry, rather than with more conventional training in technology. For the latter, the Council believes suitable provision is being made. The numbers of students in the faculties of technology in the universities are now almost exactly double the pre-war numbers. It is understood that the University Grants Committee is trying to strengthen all existing departments of applied science, so as to provide for this expansion and to improve the quality of the university training given; and the Council does not appear to have probed further into the problems involved in this expansion, either as to the content of such technological education or its distribution, though it is remarked that care must be taken to ensure that the shortage of suitably qualified staff does not result in too wide a dispersal of our available resources.

Presumably, therefore, the examination and determination of such questions is being left to the Sub-Committee of the University Grants Committee, although one would have expected that some at least of these questions would require attention at a higher level, as is indeed suggested both by the terms of reference of the Advisory Council itself, to study and make recommendations on "the arrangements for securing an adequate flow of scientific man-power to meet the needs both of Government and of industry", and by passages in the recent report on "Colonial Research, 1948–49". The Sub-Committee of the University Grants Committee may indeed be asking the right questions; but it is a matter of opinion whether a sub-committee will have the weight and authority to secure the answers. Nor is there any published evidence that this vital matter, raised in some of the earlier reports on industrial research

* Advisory Council on Scientific Policy. Annual Report. (London: H.M. Stationery Office, 1949.) 6*d.* net.

towards the end of the War, is really being considered at the highest level.

In this respect, therefore, the second report from the Advisory Council on Scientific Policy is disappointing. The urgent need in industry for an increase in the number of men of the highest quality who have received an education up to university honours standard in pure as well as in applied science, while undoubted, is secondary and may well be met incidentally if the real problems of higher technological education are faced and the right balance between academic and technological education struck. Since the Advisory Council recognizes that the foundations of such training can only be laid in universities where teaching and research in the fundamental sciences are carried out, it cannot be unaware of the importance of striking such a balance.

The Advisory Council suggests that the right long-term policy should be to provide facilities for studying the fundamental sciences up to honours degree standard, followed by a further course in an applied science; or of a course, of four or even five years duration, in which fundamental and applied science would be combined. The nearest existing courses of this type are provided at the Imperial College of Science and Technology, London; but the Council suggests that any new developments should be provided in departments much more closely welded into the life of the universities to which they are attached than obtains with the Imperial College. At both the undergraduate and the postgraduate stages the students should be in daily contact with contemporaries in other faculties.

The Advisory Council has the courage of its conviction that higher technological education of this type must be regarded as of the university type, and states boldly that this implies that the development of such higher technological education should be entrusted neither to the Ministry of Education nor to local authorities, but to the University Grants Committee. There is no more important recommendation in the report which the Council submitted to the Lord President of the Council on June 25, 1948, and which has since been sent to both the Minister of Education and the University Grants Committee, and has also been referred to the National Advisory Council on Education for Industry and Commerce. Implementation of this recommendation would be the first step towards shaping a real national policy and the appropriate distribution of resources. It should also promote the establishment of healthier relations between the universities and colleges of technology, apart altogether from contributing to the readier interchange both of staff and of students which is equally important.

The Advisory Council also expresses the opinion that the inadequacy of education in higher technology in Great Britain has been to a considerable extent due to the unsatisfactory relationship between industry and the universities. While this situation is rapidly improving, the Council suggests that industry in all its branches should be encouraged still further to recognize the value of university graduates with the highest qualifications, and to realize that the universities are ready to study industrial needs. It stresses the plain fact that teachers of applied science in the universities should, wherever possible, have had first-hand industrial experience. It is also important to remove the long-standing prejudice existing in Great Britain in favour of a career in the pure sciences as against the applied sciences.

The establishment of colleges of applied science similar to the Imperial College of Science and Technology but more closely associated with the universities is of course a long-term policy; but the Advisory Council makes two specific recommendations as short-term measures. The first of these is the expansion of existing university departments of applied science. The second is the sending of up to a hundred men a year for full courses of higher technological training at selected institutions in the United States or certain countries in Europe. Arrangements for sending fifty men have already been put in hand, and the Advisory Council states that the University Grants Committee is already taking steps to bring about some of the developments suggested, including the establishment of facilities for higher work in technology at a small number of universities.

Beyond this it may be said that in the present report the Advisory Council takes the view that the present is a period of consolidation until the far larger number of graduates in science and engineering, who are expected from the expansion of the universities, make new developments desirable and possible. Meanwhile, the Council is reluctant to recommend starting completely new developments except for special and compelling reasons. The main emphasis is laid upon the importance of applying science in the most efficient manner possible as a basic condition of our future prosperity. The report concludes with the observation that, in the long run, the precarious economic position of Britain cannot be expected to improve unless the industries of the country employ a sufficient number of men adequately trained to apply and develop the discoveries of pure research.

It will doubtless be found that the Advisory Council on Scientific Policy has not dismissed the question of higher technological education quite so cursorily as this second report appears to suggest. In the meantime, in recommending that the matter of higher technological education in Great Britain should be entrusted to the same body as that responsible for the general oversight of university development, the Advisory Council has done real service. If it has not seen fit to ask and discuss the fundamental questions as to the content of academic and technological education and the distribution of resources to meet our immediate and our long-term needs, its general responsibility for arrangements to secure an adequate flow of scientific man-power will assuredly require it to review the situation again from time to time, and to assist in dealing with some of the difficult problems in which the co-operation of industry or of Government, as well as of the universities and technical colleges, is essential.

INDETERMINISM IN PHYSICS

Natural Philosophy of Cause and Chance

Being the Waynflete Lectures delivered in the College of St. Mary Magdalen, Oxford, in Hilary Term 1948. By Max Born. Pp. viii+216. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 17*s.* 6*d.* net.

READERS of *Nature* may recall a vigorous controversy, conducted in its correspondence columns in 1944 and 1945, on the question whether present atomic ideas demand the abandonment of determinism. In the book which is the subject of the present review, Prof. Born comes down definitely on the side of the indeterminists. His book is not, however, in the main concerned with philosophical ideas. Rather it is an account of the historical development of parts of theoretical physics, explaining where strict determinism has been replaced by statistical concepts.

The subjects briefly treated include Newtonian mechanics, thermodynamics, kinetic theory, statistical mechanics and atomic theory. Naturally, no full historical treatment of all these can be given in the space of a single slender volume; Born has to select a few main points to illustrate his argument. He is especially interesting when describing ideas of men of science whom he has known personally—when describing, for example, how statistical ideas helped Planck to derive his radiation law, and Einstein to develop the theory that radiation was composed of quanta. His accounts of recent work are the more valuable because of his personal share in it; the last work described is that recently done by Born, with H. S. Green, on the kinetic theory of liquids.

Mathematical formulæ appear in the text; but, as in Born's "Atomic Physics", most of the detailed mathematical proofs are relegated to a series of appendixes, which take up some eighty pages of the book. These proofs cover an extraordinary variety of subjects. The Maxwell–Boltzmann distribution function is derived in three distinct ways; an explanation is given of the method of Darwin and Fowler in statistical mechanics; the properties of the density matrix are considered; and other mathematical sections treat Newton's law of gravitation, Brownian motion, irreversibility, the multiple distribution function in liquids, and gas degeneracy. Dealing with such a wide variety of separate subjects, the appendixes inevitably cannot provide an introduction to the mathematical theory for a reader unacquainted with the general ideas. On the other hand, the reader already knowing something, and desiring to systematize his knowledge, will find them invaluable, because of their clarity, compactness and mathematical elegance.

One detail only am I inclined to criticize in the historical account. Imbued with something of a missionary zeal, Born introduces Caratheodory's powerful and elegant method in considering the second law of thermodynamics. His account of the method is not altogether easy to follow; because of his compactness, it is not always immediately clear when he is considering reversible processes and when irreversible; moreover, the example of non-integrable planes on p. 40 is wrongly quoted. It would be a pity if trifles like these were to obscure the true worth of Caratheodory's method.

I feel less happy about the more philosophical aspects of the book. This is in part because Born, busy with the details of the historical development, only occasionally straightens his back to survey the whole landscape; in part, too, because he does not state his ideas in full, but leaves the reader to piece together his point of view from hints. But I also feel that his arguments are not always logically unobjectionable. This last statement is prompted by no disagreement with his final conclusion, that indeterminism has come to stay, because the whole structure of quantum theory is bound up with it. That conclusion I accept; but some of the subsidiary points of the argument seem not well reasoned.

For example, Born takes, as one of the minor attributes of physical causation, antecedence—the cause precedes the effect. He states that causation in Newtonian mechanics violates antecedence—the equations are unaltered if the time direction is reversed, and so provide no means of deciding whether the cause precedes or follows the effect. He accordingly turns to thermodynamics, the irreversibility of which provides an objective test distinguishing the positive and negative time directions. One might object that classical mechanics, through friction and similar forces, has plenty of irreversible processes of its own; but actually the particular test used to fix the positive time direction is irrelevant in deciding whether one event precedes another.

Again, Born seems to imply that the acceptance of indeterminism makes it easier to reconcile the reversibility of dynamics with the irreversibility of thermodynamics. I question this; indeterminist quantum mechanics still leaves it possible that the molecules of a quantity of gas should, by a remarkable succession of accidents, sort themselves out in such a way that half the gas becomes hotter than the other half. One obtains irreversibility in kinetic theory, not by abandoning determinism, but because of approximations necessarily made in introducing statistical ideas.

I could give other examples, but it would scarcely be appropriate for me to do so. After all, they refer only to details; and when a master like Born writes a book on the subject of which he is a master, it is only fair to expect those interested to read it, and find out for themselves whether they disagree with his arguments. And this I recommend them to do; whether they agree or not they cannot fail to be stimulated.

T. G. COWLING

EFFLUVIA

Odors

Physiology and Control. By Carey P. McCord and William N. Witheridge. Pp. x+405. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 39*s.*

The Chemistry of Perfumery Materials

By R. W. Moncrieff. Pp. vii+344. (London: United Trade Press, Ltd., 1949.) 30*s.* net.

SINCE "Odors: Physiology and Control" is probably the first book of its kind to be written, there are no standards for direct comparison; of the many volumes which have been written on the subject of odour this constitutes the first systematic survey of how to deal with those odours which we do not enjoy. From a purely factual point of view it is possible to divide the book into three distinct sections—the first thirty pages being devoted to the physiology of odour; thence to page 100 chemistry

receives the preponderance of attention; but the residue of the volume, some three hundred pages, is concerned with the causes, detection and removal, suppression or neutralization of household and industrial odours—those smells which were politely alluded to by our Victorian ancestors as 'effluvia'. The survey extends to the subjects of offensive trades, air-conditioning, odours as warning agents, the making of odour surveys and the legal aspects of the subject of nuisance by odour. An excellent bibliography is included which covers 123 pages and cites nearly four thousand references. The authors expressly disclaim completeness for this bibliography; but it still remains by far the most comprehensive assembly of references on this subject that has been published.

It was the objectionable odours which gave to chemistry its popular sobriquet, so aptly derived from the Anglo-Saxon *stincan*; it is therefore only common justice that applied chemistry and chemical engineering should be pressed into service for their control. Civilized communities have come to demand a freedom from domestic and industrial effluvia which would have seemed impossible even a century ago; and pure air and water free from all residual taint, together with clean streets, inodorous sewage disposal and similar amenities, have ceased to be regarded as exceptional and are now considered as the norm.

The processes and plant described in this volume have grown up in the successful endeavours made by industry and municipal enterprise to control and eliminate noxious and objectionable smells. Notable exceptions are, of course, the accumulation of petrol and diesel-oil fumes in busy city streets and the soot and smoke from the burning of raw coal, and these may ultimately, we hope, be conquered. On the whole, however, these endeavours have been successful, and the authors have given in this volume a detailed, well-documented account of the measures to be applied in the diagnosis and treatment of unwanted effluvia. A criticism may be made in respect of the scanty and somewhat careless treatment of the more academic scientific fundamentals; Fig. 7 is upside down; turpenes for terpenes; propioaldehyde for propiolaldehyde (or propynal); and trinitro butyl xylene with an incorrect formula are all to be found in Table 1; the first sentence on p. 39 "All substances possess some vapour pressure . . ." gives a false picture of the part played by vapour pressure in relation to odour stimulus. But these are points which can easily be rectified in a subsequent edition. This work should be on the shelves of all those interested either in the purely scientific or the strictly practical aspects of odour.

Mr. R. W. Moncrieff has once again produced an 'olla podrida', this time entitled "The Chemistry of Perfumery Materials", although he includes four chapters on "A Minister of Research", "Aphrodisiac Basis of Perfumes", "Musings on Olfaction" and "Can Smell be Detected other than by the Nose?" One is tempted to ask whether Part 2 (olfactory research) and Part 3 (essays on olfaction) of this volume really ought to have been included, as such, in a work under this title. Although the author does not specifically say so, it would seem that the latter part of this volume consists of a reprinting of articles previously published in journals. This would account to some extent for the diversity of subjects and also for the repetition—the subject of the structure of irone is discussed, for example, in three chapters on pp. 98, 298 and 313 and the relevant literature references are duplicated, while a similar and even more extensive repetition is observed on the muscone and civetone theme.

In some respects, particularly in its waywardness, this book resembles the author's previous work "The Chemical Senses"—and indeed covers, to some extent, similar ground. The ordered arrangement of perfumery materials according to chemical classes is new, however, and effective in bringing together the chemical information concerning the establishment of structure, and the synthesis, of most of the substances used in the trade. One notices, once again, the complete omission of allyl caproate—the pineapple aroma *par excellence*—from the section on esters, and of ethyl vanillin from that on aldehydes. It is a criticism of the general treatment that in many cases the author cites the full experimental details better reserved for the original communication.

In spite of the 'mixed-bag' in the second and third parts of the book there are few misprints or errors, and the author is to be congratulated on having so successfully steered his manuscript through the hands of a compositor who is obviously not entirely at home with structural organic formulæ. One notes, however, the author's conviction that the acetone of commerce is made by calcination of calcium acetate (p. 109); he is, apparently, overlooking the fact that the cause of odour in 'acetonical breath' is acetone (p. 80); one catches him attributing to Sir Robert Robinson the suggestion of the conversion of oleic acid to civetone via 9-octadecene,1 : 18-diacid, a suggestion to be found in the literature at least fifteen years earlier. These, however, are only trifling defects in a useful compilation, and the author is to be commended for bringing together between two covers the extremely scattered literature on perfumery materials.

G. M. Dyson

POLYGENES AND QUANTITATIVE INHERITANCE

Biometrical Genetics

The Study of Continuous Variation. By Prof. K. Mather. Pp. ix+162. (London: Methuen and Co., Ltd., 1949.) 18*s*. net.

THE theory of the gene is derived from the study of factors which can be followed individually by means of their clear-cut phenotypic effects. However, those characters which are the most important to the breeder show continuous variation and are not obviously controlled by genes. Thus, something of a gap, which research has been slow to bridge (owing to preoccupation with discontinuous inheritance), has separated the gene theory from biometry, the science dealing with metrical characters.

The key to the understanding of quantitative inheritance is the multiple-factor hypothesis, clearly adumbrated by Mendel, and advocated early in this century by G. U. Yule[1] and E. M. East[2]. A special case which influenced early thought on the matter was the triplicate colour factors in wheat reported by H. Nilsson-Ehle[3]. But, for success, a biometrical mode of analysis is essential. The pioneer in devising appropriate tools was R. A. Fisher in his early paper on human correlations[4], and later in collaboration with F. R. Immer and O. Tedin[5]. Since then, sufficient results have accumulated to justify the multiple-

factor theory as a basis for the design of experiments which can give guidance to the process of artificial selection. Prof. K. Mather himself has recently made important contributions to our understanding of the genetical systems involved, and this exposition of the ideas and technique required in their analysis is to be cordially welcomed as both timely and stimulating.

Because of general relevance to the theory of heredity, the earlier sections, which outline the properties of polygenic systems, will merit the attention of all biologists, and not merely that of professional geneticists. The value of a metrical character is affected by each one of an associated set of polygenes, which are inherited in Mendelian fashion. Their effects are similar and cumulative. Thus the character is a function of the allelic combination present, the non-heritable variation blurring the distribution of its values in a population. A polygene differs from a classical gene only in failing to have a major phenotypic effect. But since a great variety of allelic combinations entail equally advantageous phenotypes, it is the polygenes which constitute the main reservoir of useful genetic variance, and are "the genes of smooth adaptive change".

Identification of the polygenes of a system is neither possible in practice nor necessary. Instead, attention is given to certain statistical properties of the whole aggregate concerned. The familiar genetic concepts form the starting point of the analysis, but in the methodology they yield natural place to bulk properties. This is analogous to the way in which, in physics, individual dynamical properties of molecules are subsumed in bulk characteristics such as temperature or entropy. In particular, the unit of biometrical genetics is not the isolated polygene but the *effective factor*, a complex of linked polygenes, which is not permanent over the generations, but which at any stage of the selection process is the structure of interest to the breeder.

The development of these concepts, which is Mather's main theme, is admirably illustrated by the consistent use of experimental data, much of which is here subjected for the first time to this kind of analysis. This will make the book invaluable to anyone engaging in this field, even though, to keep it to a digestible length, the author has not aimed at an exhaustive treatise. Mather, as usual, has achieved a remarkably clear presentation of an intricate subject, and for a first reading the ideas of the analysis of variance should see one through.

A. R. G. Owen

[1] Yule, G. U., Royal Horticultural Society's Report of the Conference on Genetics (1907).
[2] East, E. M., *Amer. Nat.*, **44**, 65 (1910).
[3] Nilsson-Ehle, H., *Lund's Univ. Arsskrift*, 1 (1909).
[4] Fisher, R. A., *Trans. Roy. Soc. Edinburgh*, **52**, 399 (1918).
[5] Fisher, R. A., Immer, F. R., and Tedin, O., *Genetics*, **17**, 107 (1932).

PLANT BREEDING IN SWEDEN

Svalöf 1886–1946

History and Present Problems. Edited by Prof. Å. Åkerman, Dr. O. Tedin and Dr. K. Fröier; English Technical Editor, Dr. R. O. Whyte. Pp. v+389. (Lund: Carl Bloms Boktryckeri A.-B., 1948.) n.p.

THE Plant Breeding Institute of the Swedish Seed Association, commonly known as "Svalöf", was founded in 1886. This account of its history and activities was prepared on the occasion of its sixtieth anniversary; but the main purpose was "to indicate the willingness—even the eagerness—of Swedish Plant Breeding to take part again in the international collaboration of scientific plant breeders" after the period of isolation during the War.

The book consists of a series of twenty-two articles by different authors who have been allowed freedom of choice of theme and treatment—an arrangement that has inevitably led to some repetition. Some of the papers deal with the history and organisation of Svalöf and its branch stations. One of them describes the climate and soils of Sweden, and shows how the great diversity of agricultural environments demands a correspondingly wide range of crop varieties. Most of the papers are concerned with the practice of plant breeding. A general account of the problems involved in producing improved varieties of crops, of the development of breeding technique at Svalöf, and of the methods in use at present, is given in articles on "The Breeding of Self-fertilized Plants by Crossing", "Natural Selection and the Breeding of Cross-fertilizing Plants" and "In-breeding in Herbage Plants". Much the same ground is covered in greater detail in other articles by specialists on particular crops.

Three papers describe recent work at Svalöf on artificially produced polyploids and mutations. The discovery early in this century that polyploidy is common in flowering plants, and that polyploids are often of larger size than the related diploids, suggested that high-yielding crop varieties might be obtained by experimentally inducing an increase in the chromosome number. At first the only methods available were heat-shock treatment and hybridization; but since 1937 the colchicine technique has enabled polyploids to be produced with much greater frequency and less labour. None of the raw polyploids has been of practical use, but it has been found possible to improve them by continued breeding, and it is hoped that, by starting from a large number of polyploid individuals, commercially useful types will eventually be bred. Some types of *Triticale*, produced by crossing wheat and rye, have valuable properties such as a high protein content of the grain, good baking quality and extreme winter hardiness and earliness, and yield well on poor sandy soils. Work has been in progress for nearly twenty years on mutations induced by treatment with X-rays and, very recently, with mustard gas and neutrons. So far, no artificially induced mutants have been introduced into agriculture, but some of the *erectoides* mutants of Maja barley, which combine earliness and stiff straw with a good yield, may prove to have practical use. The ultimate aim of being able to control and direct mutation is still far from being achieved.

The account of the work of the Cereal and Chemistry Laboratories amounts to little more than a list of investigations. Many of these relate to problems, such as the artificial drying of combine-harvested grain, that are of immediate concern in British agriculture. A short statement of the results obtained would have been valuable, especially as many of them have not been published elsewhere.

Though this book is presumably intended primarily for plant breeders, many of the articles will be of interest to a wider audience of agriculturists. A reader who wishes to browse will find the lack of page headings a minor obstacle. In other respects the book is well produced and illustrated.

D. J. Watson

Adolescence, its Social Psychology

With an Introduction to Recent Findings from the Fields of Anthropology, Physiology, Medicine, Psychometrics and Sociometry. By Dr. C. M. Fleming. (International Library of Sociology and Social Reconstruction.) Pp. vii+262. (London: Routledge and Kegan Paul, Ltd., 1948.) 16*s*. net.

DR. CHARLOTTE FLEMING'S work on the social psychology of adolescence is one which has not received the prominence it deserves. Not only does the author write with a pen which unerringly traces the right word, but her beliefs are also substantiated by a wide acquaintance with the relevant literature which is freely referred to in this book. The way these references are used suggests that Dr. Fleming collects and uses her facts with scientific detachment, and that the views she has formed are likely to be of considerable significance. It is not surprising, therefore, to learn that the book differs from many previous works on adolescence, with their emphasis on characteristics which young people are supposed to show as they grow up.

Dr. Fleming rebels against the treatment of adolescents in terms of the average, and shows that the effectiveness of education depends upon the study of children always as individuals. The work of theorists like Rousseau and early observers like Stanley Hall and Freud are shown to be inadequate to the understanding of youth and, instead of the storm and stress, conflict and rebellion, moodiness and apathy which have been built up as the legendary experience of all adolescents, Dr. Fleming redirects attention to the continuity of human growth, the gradualness and irregularity of human development and the extent of human educability and adaptability. Although many may feel that Dr. Fleming has gone too far in upsetting accepted ideas on adolescence, there will be many more who will welcome this scientific treatment of an important period in the maturation of human beings.

T. H. H.

Children of the People

The Navaho Individual and his Development. By Dr. Dorothea Leighton and Dr. Clyde Kluckhohn. Pp. xvi+277+15 plates. (Cambridge, Mass: Harvard University Press; London: Oxford University Press, 1948.) 25*s*. net.

THE authors have been working among the Navaho for several years and have already published "The Navaho", an account of their life and environment. The present work deals with the individual, and particularly with the child and his environment.

The Navaho, like other Indian peoples, are feeling the pressure of white civilization to an increasing extent, and it is the duty of the employees of the Office of Indian Affairs to help them to accommodate themselves. The Indian Education Research Project, for which the authors are working, is trying to equip them with the requisite knowledge. It will not be necessary to tell those who have read their previous book that Drs. Leighton and Kluckhohn bring the greatest possible sympathy and understanding to the task.

A good deal of space is taken up with the results of intelligence tests, and they are compared with the performances of white children; the value of this is difficult to appraise, but it appears that some at least of these tests do not give natural intelligence a fair chance in comparison with school education. The book, like its predecessor, is well produced and illustrated, and is, in the main, easily readable.

G. H. S. BUSHNELL

Pioneers of Fertility

By Crichton Porteous and Michael Ayrton. Pp. 126. (London: Fertilizer Journal, Ltd., 1948.) 10*s*.

IN this very readable little book the author sets out the achievement of twenty-two agricultural pioneers who left their mark on English farming from the middle of the sixteenth to the end of the nineteenth centuries. All are English except one—the great German chemist, Justus von Liebig, whose stimulating book published in 1840 cleared the way for the modern period. Few of these personalities were farmers in the ordinary sense of the word, for farmers had little time or inclination for writing, still less for exact experimentation. Some were landlords like 'Turnip' Townshend, the Dukes of Bedford and Coke of Norfolk. Arthur Young was a writer. Some, such as John Mechi and Knight of Exmoor, drew their money from industry and put it into the land. Sir Humphry Davy, Lawes and Gilbert were men of science. All had their eyes fixed on what they rightly regarded as a matter of supreme importance —to raise the output of the land and to maintain it in its improved condition. The book is written in a lively style and has a number of imaginative drawings by Michael Ayrton. It forms a useful introduction for general readers, while students will be encouraged to read further upon the same lines.

British Birds in their Haunts

By the late Rev. C. A. Johns. Edited and revised by W. B. Alexander. Twenty-fifth edition. Pp. xv + 286 + 69 plates. (London: Routledge and Kegan Paul, Ltd., 1948.) 16*s*. net.

MODERN books about British birds are legion, most of them excellent, yet the most scientific of ornithologists looks back on certain books of his boyhood with a sigh of loving regret. Such, no doubt, was the feeling of Mr. W. B. Alexander when he picked up Johns's "British Birds in their Haunts"; indeed, he says in the preface to this latest edition that one of his most cherished possessions as a boy was a copy of "Johns" received as a Christmas present when he was seven years old.

Johns's "British Birds" not only reigned long as a classic of its subject, but also started many a young person on the path of ornithological research. Probably more people to-day owe their love of birds to its author than to any other writer. It was, and is, a good book; but times change, scientific classification has been altered and scientific names, too; in short, Johns needed bringing up to date. No one was better qualified to undertake the task of modernizing the book than Mr. Alexander. It is obvious he approached it lovingly and he has done it admirably.

We have before us the old "Johns" but thoroughly revised. For example, the editor has rearranged the sequence of orders and families in accordance with modern practice; but within each family the species have been left as Johns arranged them. The status and distribution of many birds has changed since Johns's day and in some cases is better known, so where changed circumstances demand it additional information is given. In short, this revised edition gives us an up-to date and reliable guide to "British Birds in their Haunts".

FRANCES PITT

THE SNOWY RIVER PROJECT (S.E. AUSTRALIA)

By Prof. S. E. WADHAM
University of Melbourne
and Prof. D. M. MYERS
University of Sydney

IRRIGATION in Australia, which began in the 'seventies and staggered uneasily for half a century, during which it learned its lessons and found the appropriate techniques, has come into its own in the last two decades. Its extension is regarded as an essential feature in national development. Most parts of the continent lack permanent streams; but among the ranges which run parallel to the eastern coastline are several areas high enough and wide enough to form catchments yielding large volumes of water. Some are snow-clad for several months, and thus have a run-off which tends to have a better distribution than others. Among these, the plexus of ranges and tablelands in the Mt. Kosciusko region of the south-east is the outstanding example. This area contains the Murray catchment and those of its tributaries, the Murrumbidgee and the Tumut, and of the Snowy. The Murray has a system of storages and locks developed during the last forty years, while the Murrumbidgee has the Burrinjuck storage and several locks. The Hume reservoir on the Murray holds 1,250,000 acre feet, and will be extended to hold 2,000,000 acre feet. Burrinjuck holds 662,000 acre feet for irrigation. The Snowy, with an average yearly flow on the tableland of 970,000 acre feet, remains as the largest stream in the region available for future development. It rises under Mt. Kosciusko, and after flowing north, turns southward and falls rapidly near the border of New South Wales and Victoria to reach the ocean near Orbost. Its lower reaches have a considerable system of alluvial flats which do not need irrigation, but the country surrounding them is too poor and too uneven to be worthy of intensive development. From the agricultural point of view it is therefore preferable that the water should be diverted across the ranges towards the dry inland.

The use of water for power generation was neglected in the earlier days; but with increasing industrialization the need for this development became clear. Tasmania showed the way with its extensive system developed during the 'twenties. The difficulty of using water both for irrigation and electric generation lies in the seasonal nature of the requirement for the former, which is in contrast to the continuous use desirable in electric power systems. Clearly, it is almost essential that a dual-purpose project should be linked to a grid system of distribution. Such systems are evolving in parts of New South Wales and Victoria.

Many schemes have been put forward for the utilization of the Snowy waters. It became clear that, as two States and the Commonwealth were involved, no action could be taken without either mutual agreement or a most expensive legal argument. Agreement was reached in February 1949 on the basis of a report* submitted by Commonwealth and State officers.

The proposals contained in that report are for the interconnexion of the headwaters of the four main river systems (the Murray, Murrumbidgee, Tumut and Snowy systems) with the view of using them to the best advantage for irrigation at the lower reaches of the Murray and Murrumbidgee, but with interchange of flow in the upper reaches for generation of electricity under the most favourable conditions. The Murray and Murrumbidgee themselves do not fall rapidly enough for this purpose; but the Tumut, Tooma (a tributary of the Murray) and part of the Snowy have sufficient gradient to provide satisfactory conditions for power generation.

There are several possible alternatives, and the final decision was reached after considering the relative importance of distribution of waters for irrigation, magnitude of power production, and the overall economics of both. The decision involves primarily the diversion of a large proportion of the Snowy waters indirectly to the Murrumbidgee. It has yet to be decided, after more detailed investigation, whether the remainder should be diverted to the Murray or the Murrumbidgee.

The details of the proposals may be examined in relation to the map of the area shown in Fig. 1. The main areas chosen for power production are: (*a*) the upper reaches of the Snowy; (*b*) the Tumut valley; and (*c*) the area between the Snowy and the Murray. The flow of the Tumut River will be supplemented by the headwaters of the Tooma and of the Eucumbene branch of the Snowy, and lower down by waters of the upper Murrumbidgee. In the agreed part of the scheme the diversion from the Snowy to the Murray will be increased by a total amount equal to that lost by the Snowy. The remaining waters of the Snowy will be diverted either to the Murrumbidgee at Billilingera (the Snowy–Murrumbidgee–Murray–Tumut scheme), or to the Murray by the same route as the replacement diversion (the Snowy–Murray–Tumut scheme). Power generation in the Tumut system will be supplemented by the Yarrangobilly River, and in the Snowy–Murray system by the Geehi River and Bogong Creek.

A flow diagram (Fig. 2) shows the effect of the diversions on the major rivers, for the Snowy–

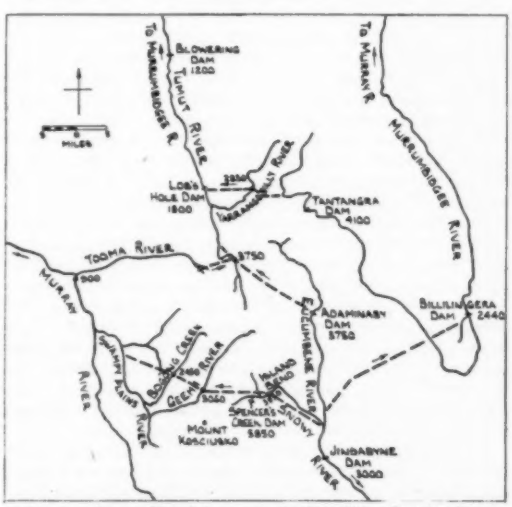


Fig. 1. Snowy Mountains area showing sites of major dams and diversions proposed (canals omitted). Figures are approximate heights in feet above sea-level

*Commonwealth of Australia: Proposals to Divert the Snowy River. Report by Commonwealth and State officers. Nov. 1948.

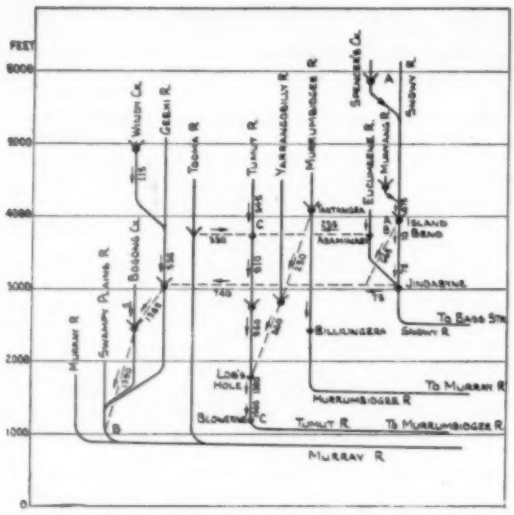


Fig. 2. Flow diagram for Snowy–Murray–Tumut scheme. Figures represent average flow in thousands of acre feet per annum.

Dams and collection points ●; racelines ↓; diversion tunnels ----. Power generation: *AA*, Upper Snowy; *BB*, Snowy–Murray; *CC*, Tumut

Murray–Tumut scheme. In the alternative scheme, the annual flow in the Snowy–Murray diversion tunnel would be reduced by 410,000 acre feet, a similar amount being diverted from Jindabyne Dam, on the Snowy, to Billilingera Dam, on the Murrumbidgee.

The total average power potential may be determined from the average flow at each dam or pond and its height above the point where the river ceases to fall rapidly. In the former scheme, the power potential in each of the three generating systems is thus approximately as follows: (*a*) Upper Snowy: 50,000 kW. (*b*) Snowy–Murray diversion (Snowy R., Geehi R., and Bogong Creek): 430,000 kW. (*c*) Tumut (Eucumbene, Tooma, Tumut and Yarrangobilly Rivers): 410,000 kW. The three systems have therefore a continuous power potential of 890,000 kW. In the alternative scheme, the diversion of 410,000 acre feet per annum to the Murrumbidgee would cause a loss of about 60,000 kW., but would have certain compensating advantages.

Having in mind the load factors at which the various power stations will operate when interconnected with existing and future generating stations in New South Wales, Victoria and the Federal Capital Territory, the proposals involve the installation of generating plant of 1,720,000 kW. capacity in the case of the Snowy–Murray–Tumut scheme, or 1,565,000 kW. in the alternative scheme.

The above analysis is based on data provided through the courtesy of the chairman of the Snowy River Committee, Mr. L. F. Loder, and used by the Committee in formulating its 1948 report. The whole area is relatively undeveloped, and it is accepted that the figures adopted are liable to modification when a more detailed survey has been made.

The magnitude of the scheme is indicated by the extent of the engineering works to be put in hand, involving the construction of more than eighty miles of tunnel and about five hundred miles of racelines. In addition, either of the alternative schemes will require the construction of seven major dams, some of them in country which has been hitherto regarded as fairly inaccessible. It is anticipated that the construction of the entire project will take some thirty years, but the benefits of the scheme will become progressively available during that time.

From the irrigation point of view, the water will be used to reinforce and extend the existing areas on the Murrumbidgee and Murray. These areas support very diverse forms of production, from dried fruits, citrus and canned fruits, and wine grapes, through irrigated pastures used for dairying or fat lambs, to rice and summer forages. In dry seasons considerable volumes are used to help crops of winter forage and grain. The allocation of water is through a system of 'rights' for which the landholder has to pay; extra supplies can also be purchased in some years. The right may be the equivalent of one foot of irrigation water over the whole holding, or may be one quarter to one tenth of a foot, depending on the nature and situation of the land. The landholder has to plan his type of production according to the size of his holding and his water-right, as various crops require various amounts; rice needs six feet, and winter forages perhaps only six or eight inches of water.

Soil problems are frequent in these areas, as the experiences of the last half-century have shown. Nowadays it is generally accepted that a more or less intensive soil survey is essential before any irrigation scheme is planned. Although some soil problems of irrigated land have not yet been solved, there is sufficient background of scientific knowledge available to ensure their satisfactory solution.

Sociologically, the more intensive the use of water, the closer will be the settlement of the land, and the larger the local units of population which can be established. Given effective leadership, such units can be more readily provided with the basic amenities which have not always been characteristic of rural areas. On the other hand, the forms of produce which lead to closest settlement, such as dried, canned and fresh fruits, and wine, are already available far in excess of Australian requirements, while the future of dairy products is uncertain. It therefore seems desirable that the water should be used to stimulate meat production and the growth of forages as reserves against the droughts which periodically afflict large areas. In this connexion it would be possible to irrigate localized areas in regions with an average rainfall of as low as 9 in. and a high degree of variability. However, this would mean passing the water down long stretches of river, with corresponding increases in the percentage lost through seepage and evaporation. The allocation of the water will thus become a very complicated problem, in the solution of which local interests must give place to the overall needs of the community.

RECENT ADVANCES IN FERMENTATION RESEARCH

A SYMPOSIUM on "Recent Advances in the Fermentation Industries" was arranged by the Scottish Sections of the Royal Institute of Chemistry as a part of a general programme of scientific courses, conferences and symposia, and held at the University of St. Andrews during July 23–30. At a previous symposium in 1947, also held at St. Andrews, the

papers ranged over the field of recent developments in industrial organic chemistry. It was now felt that the fermentation industries should be similarly treated. It must be said that the organisers of the symposium stretched their net wide and such diverse subjects as panary fermentation, potable fermentation products, industrial fermentations, mould metabolic products and methods of assay of amino-acids and penicillin were discussed.

The members of the symposium were welcomed to St. Andrews by the Principal of the University, Sir James Irvine; immediately thereafter the congress proceeded to business with the reading of papers.

The organisers of the symposium did not make the usual mistake of trying to include too much. Each speaker was allotted an hour for his paper and fifteen minutes was reserved for discussion. Another excellent feature of the symposium was the fact that there were no afternoon sessions, and members were free to do as they pleased and possibly digest what they had heard in the morning. There was generally an evening session during 6–7.15 p.m.

The first paper was by Dr. A. Olsen (Standard Yeast Co., Ltd.) with the very wide title "Yeast". The author, however, limited himself to the discussion of problems connected with the production of bakers' yeast. One of the chief problems confronting the manufacture of bakers' yeast is the suppression of alcohol formation, and this is mainly brought about by vigorous aeration of the actively fermenting cultures. The actual process of large-scale manufacture, with all its necessary controls of sterilization and cooling, was described in detail. The qualities of a good bakers' yeast were also discussed. Such a yeast must be capable of good gas production in a dough. It must have a good, light colour and emulsify easily with water. The baker must have a yeast which maintains its quality from week to week and year to year. The action of yeast on flour is not a simple one of carbon dioxide production as is usually supposed. There are other and complex factors involved, which are still little understood. For example, there is the question of the maturing action of yeast proteins on gluten. Apparently, brewers' yeast is unsuitable for this purpose.

In the second paper, Dr. I. A. Preece (Heriot-Watt College, Edinburgh) gave an account of the materials encountered in malting and brewing, with special reference to the carbohydrate side of the problem and the behaviour of the α- and β-amylases in the mashing process. This is a province which Dr. Preece has made particularly his own, and a very clear picture of the complex reactions as known at present was given. A point in the mashing process to which brewers should give attention is the heat sensitivity of β-amylase. Thus, an increase from, say, 65° to 67° C. (149–153° F.) would have but little influence on α-amylolysis, whereas it would considerably restrict β-amylase activity and thereby markedly decrease the proportion of maltose and thus of total fermentable sugar in wort.

The evening session was addressed by Dr. D. W. Kent-Jones on panary fermentation. With great respect to all the other speakers, this was certainly the best delivered and most entertaining of all the papers of the symposium. We may not have learnt much about panary fermentation, but we did learn a great deal about the troubles that afflict the unfortunate baker in his daily efforts with the complex biochemical experiment of baking, to obtain a satisfactory and palatable loaf pleasing to his public. The author dealt in detail with the fundamental work on dough properties as well as fermentation changes in dough brought about by yeast. The important question of 'ripeness' of a dough was also discussed.

Dr. L. R. Bishop (Stag Brewery, London) discussed the nitrogenous constituents of brewing materials, for example, proteins and amino-acids. An account was given of the nature of the proteins in wort and their connexion with the phenomenon of 'haze' in beer. A description was also given of the absorption of amino-acids from wort by yeast.

A particularly interesting paper was read by Dr. Erik Helm (Alfred Jorgensen Laboratory of Fermentology, Copenhagen, Denmark) on a comparison of British and Continental methods of brewing. The two systems differ in a number of particulars. In the first place, a 'top' yeast, in which the major portion of the yeast rises to the surface of the fermenting wort, is used in British brewing systems, whereas on the Continent a 'bottom' yeast is employed in which the yeast sinks to the bottom of the fermenting vessel at the close of fermentation. In the second place, the temperatures at which fermentation is carried out in the two systems are very different. On the Continent low temperatures (6–11° C.) are used, whereas in British top-fermentation brewing relatively high temperatures prevail (18–22° C.). The methods of mashing are also different. The British system uses a wort prepared by an infusion process, while on the Continent a decoction method is followed. With these differences in mind, Dr. Helm discussed certain aspects of the nitrogen changes in the two systems; particularly with regard to the total amount of amino-nitrogen taken up from the wort, which is very much less in bottom fermentation systems than in top fermentation brewing. There are also differences in behaviour in the absorption of individual amino-acids, such as methionine, which is completely absorbed in twenty-four hours by 'top' yeasts, whereas it only gradually disappears in bottom fermentation.

In the Industrial Fermentations Section the production of industrial alcohol from molasses was described by Dr. E. R. Dawson (The Distillers Co., Ltd.). The period between the two World Wars has seen striking developments in the type and purity of the yeast used for molasses fermentation and also in the type of fermentation plant employed. Strains of yeast are now selected which are not only capable of tolerating high concentrations of alcohol but also maintain their stable and uniform characteristics. In recent years three principal lines of progress in the fermentation of molasses for the production of alcohol have been developed, namely, the development of continuous fermentation processes, methods for improving the medium prior to fermentation, and the recovery of the yeast at the end of fermentation and its use in subsequent fermentations.

Acetone-butanol fermentations were discussed in great detail by Mr. E. Gill (Commercial Solvents (Great Britain), Ltd.) and other industrial fermentations such as the production of 2 : 3 butylene glycol and glycerol were described by Dr. G. G. Freeman (Nobel Division, Imperial Chemical Industries, Ltd.). Other fermentations, for example, acetoin (acetylmethyl carbinol) were also briefly discussed. So far as the 2 : 3 butylene glycol fermentation is concerned, recent work has established the existence of three distinct fermentations brought about by three different organisms, *Aerobacter aerogenes*, which fer-

ments hexoses yielding a mixture of *d*- and *meso*-isomers of the glycol, in which the *meso*-isomeride is the main product; *Aerobacillus polymyxa*, which ferments starches and dilute sugar solutions to yield *l*-2 : 3 butylene glycol and ethanol; and lastly, *Aeromonas hydrophila*, which gives rise to *l*- and *meso*-2 : 3 butylene glycol isomers; while ethanol and lactic acid are the main non-gaseous products. A description was also given of the various methods of glycerol production from modified alcoholic fermentation. The mechanism of glycerol production was also discussed, together with the practical details of isolating the product from the fermented liquors.

The use of fungal amylase in the industrial production of alcohol and alcoholic products was discussed by Dr. R. W. Jackson (Northern Regional Research Laboratory, U.S. Dept. of Agriculture, Peoria, Illinois). The heavy demand in the United States for alcohol production during the Second World War led to the investigation of various methods of starch conversion to fermentable sugars. The amylases produced by moulds were found to be efficient converting agents—a fact that has been known for many years. A wide survey was made of different moulds which included 350 strains belonging to forty species of five different genera. In actual practice, two strains of *Aspergillus niger* were most used in this work. The amylase system of moulds was found to consist of α-amylase alone; no β-amylase being present. This α-amylase differs in some respects from malt α-amylase; for example, it does not liquefy starch as rapidly, and, furthermore, it is more thermolabile. Although fungal-α-amylase is essential for saccharification of starch, alcohol yield was found to be better correlated with another enzyme which has been termed 'maltase'. This maltase hydrolyses maltose and higher glucose polymers to glucose. The amounts of maltase and α-amylase show considerable variation from one mould to another. The fungal system was also found to be capable of hydrolysing the α-1 : 6-glucosidic linkage of isomaltose. A wide range of starches from different sources, for example, maize, wheat, sorghum and potatoes, are attacked by fungal amylase.

The third and last session of the symposium was concerned with microbiological advances, and was under the chairmanship of Prof. W. H. Everett. Dr. J. H. Birkinshaw (London School of Hygiene and Tropical Medicine) described various aspects of fungal metabolism with special reference to the major products of fermentation of *Aspergillus* and *Penicillium* species, namely, oxalic and citric acids. The discovery of the production of citric acid by *Aspergillus* species has now been developed into an industrial process of considerable commercial importance. Moulds, however, are capable of producing a very wide range of complex metabolic products which include not only aliphatic but also aromatic and heterocyclic derivatives. For example, among the aromatic products of mould metabolism, a whole series of phenols and phenolic acids of varying degrees of complexity are encountered. Some of these substances can be regarded as being based upon 2 : 4 dihydroxybenzoic acids, whereas others are *p*-quinols and thus closely related to the benzoquinones which are also produced by mould metabolic activity. There is strong evidence for the view that the quinols and their corresponding quinones, which frequently occur together, form an oxidation-reduction system which is intimately connected with the respiratory system of the mould cell. Even more complex compounds than phenols and phenolic acids have been met as mould metabolic products. For example, a number of hydroxyanthaquinones have been isolated from fungi, but oddly enough, only one example of a naphaquinone has been found. Dr. Birkinshaw also referred to the production of compounds by moulds which contain other elements besides carbon, hydrogen and oxygen, for example, nitrogen, sulphur and chlorine, in their molecules. Fungal antibodies of known structure are examples of this type of compound which have proved their value in chemotherapy, and are therefore of great importance in the medicinal chemical industry.

The question of microbiological assay of amino-acids was discussed by the present writer. Microbiological assays of amino-acids have a number of advantages over chemical methods because they are relatively rapid to carry out and do not require expensive and elaborate apparatus. Undoubtedly one great advantage of microbiological assay methods over chemical determinations lies in the fact that in a mixture of leucine and *iso*leucine differentiation is specific and exact. Up to the present time no chemical method of estimation has been devised which is capable of giving accurate values for these two amino-acids when present together.

An interesting paper on the assay of penicillin with particular reference to the micro-chromatographic technique was read by Mr. C. R. Bond (Dyestuffs Division, Imperial Chemical Industries, Ltd.). The assay of penicillin really resolves itself into two parts: (1) the determination of total penicillin, and (2) the determination of the relative amounts of the individual penicillins, because penicillin as produced by suitable types of mould consists of at least ten acids which possess the same characteristic structure with different side-chains. Mr. Bond described the various methods for estimating total penicillins in the form of total anti-bacterial activity against a specific organism by micro-biological methods. A critical evaluation was then given of the various methods which have been suggested for the assay of the purer forms of penicillin and for the determination of individual penicillins themselves, such as the iodimetric method, counter-current distribution methods and the paper strip method, which makes use of distribution between two solvents. This last method embodies the micro-chromatography of a trace of sample on a buffered filter paper strip followed by mounting of the strip on an inoculated agar plate. After incubation, inhibition zones due to the different penicillins are produced in the agar around the paper strip, and from them the relative amounts of the individual penicillins can be calculated.

The final paper to the symposium was contributed by Mr. A. Parker (Dyestuffs Division, Imperial Chemical Industries, Ltd.) on aseptic technique in industrial-scale fermentation. This subject, of course, is of especial importance in the large-scale manufacture of such products as penicillin. A close approach has been made to this ideal by the design and operation of the plant. Thus 'seed' cultures are prepared so that all possibilities of contamination are guarded against. Again, the plant itself must be capable of complete sterilization and must be so devised as to exclude all contaminants.

The Friday and Saturday of the symposium week synchronized with meetings of the Biochemical and Physiological Societies at Dundee and St. Andrews respectively. The social side of the symposium was not neglected and visits were arranged to various places of interest.

E. BARTON-WRIGHT

MINERAL RESOURCES OF THE BRITISH COMMONWEALTH AND EMPIRE

THE Fourth Empire Mining and Metallurgical Congress, meeting at Oxford under the presidency of Sir Henry Tizard, devoted July 13 to a discussion of the mineral resources of the Commonwealth and Empire countries, with particular reference to changes in the last two decades. Members had before them advance copies of nine papers, dealing with Australia (P. B. Nye, I. C. H. Croll and D. R. Dickinson), the Union of South Africa (A. R. Mitchell), Canada (G. C. Monture), Malaya and the Far East (L. L. Fermor), British West Africa (N. R. Junner), the East African colonies (E. O. Teale), India (D. N. Wadia), Southern Rhodesia (J. C. Ferguson) and Northern Rhodesia, Trinidad, British Guiana and Cyprus (E. H. Beard). These contain a wealth of factual information from which it is possible to select only a few items for comment.

Statistical estimates of the future potentialities of Empire mineral production for most minerals were either incomplete or not attempted in these papers, no doubt because in the present state of development or of collection of information in the countries concerned, such estimates are not possible. A notable exception, however, concerned the gold-mining industry of the Union of South Africa. Mr. D. G. Malherbe, introducing Mr. Mitchell's paper, pointed out that while it is expected that there will be a gradual decline in the tonnage of ore milled from the main Witwatersrand area, the recent new discoveries in the Orange Free State and Western Transvaal are estimated to be capable of providing sufficient ore to maintain the present rate of milling in the Union as a whole (approximately 56 million tons per year) until 1974. As, moreover, the ores of the newly found areas appear on the average to be richer than those of the Rand, it is probable that the annual yield of gold would be greater. A passing reference was made in this paper to the presence of uranium in small quantities in the gold-bearing reefs of the Witwatersrand conglomerate. It was emphasized that the development of other mineral raw materials, such as asbestos, manganese, chromite and antimony, within the Union has been nurtured by the profitable gold- and diamond-mining industries.

Dr. W. B. Timm maintained that in Canada the primary object of every prospector is to find gold, and that the discovery of many other useful metalliferous deposits has been an incidental result of the search, including the great base-metal deposits of the central and western provinces. Gold had likewise been the first object of the Southern Rhodesian mineral industry, though here a decline in production has now set in. A serious view is therefore taken of the effects of the war-time curtailment of development of precious metals, for example, in Canada and East Africa, which was necessitated in order to release man-power for the mining of minerals more needed at that time.

During the twenty years under review, a number of notable developments have taken place. The copper belt of Northern Rhodesia, of world-significance, was brought into production by the combined efforts of geologists and mining engineers. In Canada, where only twelve years ago there was no domestic production of iron ore, two major fields of occurrence of Pre-Cambrian hæmatite iron formations have been found. One, at Steep Rock, Ontario, is already yielding a million tons of ore annually; another, on the Labrador–Quebec border, is estimated after only three summers drilling to contain 300 million tons. Another recent discovery is the spectacular diamond-pipe found by Dr. Williamson in Tanganyika, which is stated to have yielded diamonds worth £500,000 in the past quarter. On the other side of the picture, besides hindering prospecting and leading to unduly rapid exhaustion of reserves of some materials, war-time conditions have caused great disruption to the important Malayan tin industry, which has twice suffered a 'scorched earth' policy, once at British and again at Japanese hands. Here progress towards recovery is now being made; production has risen from 27,000 tons of tin in 1947 to 45,000 in 1948 according to Mr. A. H. M. Cretch. It is expected, however, that the easily found alluvial deposits will become exhausted in a measurable (though unstated) time, and it was urged that attention should be turned to the more difficult task of locating the primary deposits in the bedrock.

In presenting the paper on India, Dr. S. K. Chatterjee said that his country contains resources of four minerals in amounts which should be regarded as of world importance: iron ore, titanium ore, thorium ore and mica. According to Sir Lewis Fermor, the iron ore reserves may well amount to 10,000 million tons. Canada is likewise already exporting iron ore, and a plea was made during the discussion that at least part of the high-grade ore from the new Labrador–Quebec district should be made available to the British iron and steel industry. In South Africa there are large iron ore reserves, but the industry is unable to meet present demands for steel in the Union. Australia's reserve of 200 million tons is regarded as adequate for domestic needs, but Prof. J. N. Greenwood pointed out that this is by no means a large reserve, when the size of that continent is taken into account. Considerable supplies of manganese exist within the Commonwealth, notably in India, on the Gold Coast, and in South Africa. The Commonwealth also contains some of the great base-metal producing units of the world; for example, the Australian Broken Hill, Mount Isa and the Canadian Sullivan lead–zinc mines, and the Sudbury nickel–copper mines. The fear was expressed that the concentration of production of these metals into a few large units of this sort is having the effect of making the disposal of parcels of ore from small operators difficult.

Considerable interest was shown during the discussion in the possible uses of titanium. Substantial sources of this metal exist in the newly developed Allard Lake deposit on the Gulf of St. Lawrence, and there are great untapped reserves—estimated at 2,000 million tons—in the Bushveld igneous complex, South Africa. Other sources include the zircon–rutile–ilmenite–monazite sands of the New South Wales and Queensland coasts, the 'black sands' of Travancore (also important for their uraniferous monazite) and the *amang*, the waste material remaining from tin-recovery operations in Malaya. At present the principal application of titanium is for the manufacture of the white oxide, which makes an excellent pigment; but experimental production of the metal is being carried out by the Dominion Magnesium Company in Canada. This metal offers a challenge to the metallurgist, for it has so far proved to be difficult to smelt free from carbon, and the presence of carbide has a detrimental effect upon

its rolling properties. Prof. W. R. Jones directed attention to the working of another new industrial mineral in Canada, the feldspathoid nepheline, which is finding extensive application in ceramic manufacture.

The 'evaporite' group of minerals received scant attention in the discussion, though Sir Edmund Teale mentioned the soda deposits of Lake Magadi in Tanganyika, which are of volcanic origin. Reserves of gypsum, anhydrite and halite occur in many Commonwealth countries, but in most cases have not yet been extensively developed. Mr. V. P. Sondhi stated that a source of gypsum for mining at the rate of 2,000 tons a day is being sought in India. In Canada an occurrence of potash, perhaps comparable with the New Mexico–Texas potash field, has been found beneath the Great Plains, but this, too, awaits development.

A remark of Sir Henry Tizard during his address to the Congress at Grosvenor House, London, on July 11, to the effect that the classical days of prospecting by geological methods are ended, might be held to be negatived by the valuable discoveries made by the Colonial Geological Surveys in the past two decades. Dr. Junner, for example, recorded the finding of deposits of diamonds, gold, platinum, iron and chrome ores during this period by the Gold Coast Geological Survey. So necessary is the work of such Surveys that the Colonial Office, at the suggestion of a committee jointly set up by the Institution of Mining and Metallurgy and the Geological Society of London, has established a central directorate of Colonial Geological Surveys, and enlarged greatly the staffs of the several Surveys. Dr. F. Dixey, the director, stated that there would shortly be 110 on the scientific staff, and a figure of two hundred is aimed at.

The discussion failed to throw any further light on what, according to Mr. Hugh Gaitskell, Minister of Fuel and Power (speaking at the Congress banquet at the Guildhall on July 11), is the most urgent need of the British Commonwealth—new substantial sources of petroleum. Trinidad has for many years been the leading Empire producer, but it has now been surpassed by the Far Eastern island of Brunei. Some optimism was expressed regarding Canadian possibilities; exploration in Australia, on the other hand, has so far been unsuccessful.

The definition of what may or may not be regarded as a useful mineral reserve is so far determined by economic factors that it was resolved at the next Congress to devote one section to a consideration of the economics of mineral exploitation.

K. C. DUNHAM

AGGRESSION IN NATURE AND SOCIETY

THE conditions making for undue aggression in modern society, the need to recognize healthy and valuable forms of aggression as well as the more dangerous kinds, and the place of aggression in the biological scheme as a whole, were the main themes of a symposium held by the Medical Section of the British Psychological Society on June 22. The subject was introduced by Dr. D. A. Hanson of the Department of Anatomy, the Medical School, Birmingham, Dr. P. M. Turquet of the Social Medicine Research Unit (Medical Research Council), and Prof. D. W. Harding (Bedford College).

Dr. Hanson put the problem in its broad biological setting in order to judge what the study of aggression in animal groups can contribute to the understanding and control of aggression in human society. He treated aggression as one of the methods by which animals seek to establish satisfactory relations with other animals, and saw it as having developed concurrently with social relations themselves. The earliest aggregations of living organisms probably resulted from the operation of physical forces over which the organisms had no control (winds, tidal currents and so forth), and which eventually led to the selection of those having an evolutionary advantage in the position thus imposed upon them. Their genetic character and consequently their physiological requirements would then contribute to the maintenance of aggregations. "At first ecological, and later physiological, factors are the origin of the social contract," said Dr. Hanson.

Aggregation demands in each individual two social characteristics: some degree of tolerance for other individuals and also the capacity to compete with others when congestion brings the resources of life into short supply. Those individuals best able to obtain food and a mate become dominant in the social group. Different species exhibit different degrees of tolerance and domination within their organisations, and it seems likely that at least to some extent these differences are determined genetically. Zuckerman showed that the male baboons he studied at the London Zoo are organised into a strict order of precedence for food and females, and test the order by frequent combats; but the howling monkeys studied by Carpenter in Panama exhibit a stable organisation in which co-operation between individuals seems highly developed and fighting for food or females rarely occurs.

Aggression between groups is not a prominent feature of sub-human societies. However, group aggression has been reliably observed in defence of territory, for example, by Eskimo dogs in East Greenland, where packs of five to ten members defend their group territory against all other dogs, the young animals learning the boundaries of other packs' territories and defending their own only when they approach sexual maturity. Little is known of the extent of communal defence of territory among the higher primates, though it seems that some such group efforts, probably not much organised, do occur.

In conclusion, Dr. Hanson emphasized the wide differences between human and other animal societies, especially the differences arising from the human possession of cultures based on language. Just as anthropomorphism hindered progress in early studies of the social life of animals, so 'anthropoidomorphism' could be a danger if the scientific studies of animal groups were applied by uncritical analogy to human life in society.

Dr. Turquet based his treatment of the theme on two postulates. The first was that the presence of an inborn propensity to aggression in human beings is less important than its subsequent fate at the hands of the family and other social forces. The second was that aggression is one of several possible responses to the frustration of an impulse. Dr. Turquet therefore examined the main sources of frustration in our society.

The first he found to be the process of socialization during infancy and childhood, whereby simple naturally preferred ways of behaving are interfered with or replaced by more complicated and arduous

modes of behaviour. Undue aggressiveness may then develop owing to the mother's expectations outrunning the infant's capacity (for example, in sphincter control), or to her own unconscious conflict and guilt in exerting her power over him and the child's consequent uncertainty of affection. Early experience of this kind sensitizes the individual to those invitations to aggression which later social experience offers.

In the outer world of school and, later, of employment, the child must compete with others and will meet further frustrations while he acquires the skills on which successful competition depends. His anxiety is heightened by his mother's expectations of his success, which thus tends to be equated with being loved, while failure means rejection. For a boy the difficulty may be increased by early identification with the mother (the father tending to be a remoter figure in early childhood), which has led him to view aggressive behaviour as 'bad'—something that the mother has implicitly deplored, although from school days onwards she now expects him to show the reward of it in competitive success.

For the woman, Dr. Turquet saw two possibilities fraught with anxiety and frustration and therefore likely to add to the sum of aggression in society. One is her entry into an occupational life in which her opportunities compare unfavourably with a man's. If, on the other hand, she prefers the older domestic role with its exemption from the need to compete on the male pattern, she then faces the anxiety of choosing and securing a husband, on whose adequacy her own social status will largely depend, and to whom she will lose some of her individual identity. In either case the woman meets an atmosphere of masculine superiority which contrasts sharply with her childhood experience of the mother's seeming superiority in the home. Aggression results from the inferiority which she feels in such an atmosphere. "Hence," said Dr. Turquet, "ambivalent feelings towards motherhood, the declining birthrate, and an unconscious desire to reject the more fundamental aspects of the feminine role."

Following the biological course set by Dr. Hanson, Prof. D. W. Harding emphasized the functional value of aggression, suggesting that we are suspicious nowadays of the whole psychological mechanism of pugnacity on account of its expression in destructiveness and unnecessary attack, and tend to overlook its other manifestation as vigorous action which modifies the environment—both social and non-social—in the service of the organism's needs. The capacity for aggressive response is inborn, but the response itself is contingent on the fact that the satisfaction of some other need is obstructed or that the individual judges there to be a threat to some existing satisfaction. In maintaining this view of the contingent nature of aggression we have to make one or two provisos. We have to recognize psychopathological mechanisms that produce what seems at first sight (though not after analytic exploration) a satisfaction in aggression for its own sake. We have also to notice that pleasure in exercising the mechanisms of pugnacity leads to various forms of friendly combat, admittedly satisfying in themselves but free from hostile intention. Finally, there are individual differences (traits of temperament and personality) which cause the aggressive response to occur much more readily in some people than others, though it still remains contingent on their sense of being obstructed or threatened.

Recognizing the biological function of aggression, how are we to account for the feeling of guilt or uneasy regret set up by aggression against other people, in contrast to the ease of mind that follows successful aggression against inanimate objects and natural forces? Prof. Harding suggested that the explanation lay in the sentiments that attach us, in some degree, to all other human beings and which are based on the intrinsic value to us of social companionship. These sentiments are the human developments of that basic 'tolerance' for other members of the group which Dr. Hanson had postulated as a necessity for members of aggregates even among the simpler organisms.

To the extent to which the social sentiments are developed in us, the use of force against others is bound to cause regret. Yet it may be necessary in the service of other needs and values, and when it is unavoidable the healthy response is regret rather than a sense of guilt. In theory, at all events, we can conceive of an unguilty regret at having to use force against others. In practice, a sense of guilt often occurs, and, like the undesirable forms of aggression, may be due in part to psychopathological components, a point that Dr. Turquet had illustrated in speaking of the guilt that parents may unconsciously harbour in having to control a child.

In general discussion, other speakers emphasized the importance of recognizing the healthy as well as the undesirable forms of aggression. Dr. H. V. Dicks suggested that modern societies seemed more and more to discourage healthy individual aggression and to foster submissiveness to organised groups, while at the same time wars and other outlets of unhealthy aggression became an increasing menace. Dr. J. D. Sutherland and the chairman, Dr. W. Clifford Scott, expressed a general view in suggesting that the topic, which offers many problems for further inquiry, is a field in which the clinical findings of medical psychology and the results of general psychological investigation can supplement each other with special advantage.

OBITUARIES

Dr. L. Slater

THE death occurred on August 13 of Dr. L. Slater, chief coal survey officer (Sheffield), North-Eastern Division, National Coal Board, at the age of fifty-six. Dr. Slater, a graduate of the University of Manchester, served during the First World War as an officer in the Gas Corps, and was afterwards associated with the late Dr. F. S. Sinnatt and the Lancashire and Cheshire Coal Research Association in the development of the physical and chemical survey of coal seams. In 1923 Dr. Slater went to Sheffield to found, for the Fuel Research Division of the Department of Scientific and Industrial Research, the South Yorkshire Coal Survey Laboratory, which, in its early days, was closely associated with the late Prof. R. V. Wheeler.

His work at Sheffield set a pattern which was adopted in the coal survey laboratories which later were developed in all the major coalfields of Britain. In the course of this work he made a special study of the types of spores found in coal and applied it, with success, to the correlation of coal seams. In his laboratory the relatively neglected microscopical study of coal was steadily pursued over a period of

twenty years, and important contributions were made to knowledge.

Dr. Slater was, at one time, chairman of several sub-committees of the British Standards Institution concerned with the standardization of methods of analysis of coal and coke. He was an original member of the Coal Research Club, a select body of pioneers in the scientific study of coal. On behalf of the Midland Institute, he conducted a thorough investigation into the sizing of commercial grades of coal in Yorkshire, putting forward recommendations for simplification which proved to be of great value when the matter was examined on a national basis ten years later. He was recognized as an authority on the Yorkshire Coalfield and his knowledge and advice were widely valued in Yorkshire mining circles.

R. A. MOTT
A. M. WANDLESS

Dr. D. A. Hanson

DR. DANIEL HANSON, who was killed climbing in Switzerland on July 25 when acting as a leader at an instructional meet of the Alpine Club, was the only son of Prof. Daniel Hanson, professor of metallurgy in the University of Birmingham. He was educated at Shrewsbury and the University of Birmingham, where at the time of his death he was a research fellow in the Department of Anatomy. Hanson was a brilliant student with wide intellectual interests. In 1945 he won the Chancellor's Essay Prize in competition with undergraduates from all faculties, a unique distinction for a medical student in his University. His medical education was undertaken as a preliminary to research into problems of human behaviour.

After qualifying in 1947, Hanson began work on the interrelations of neural and endocrine factors. His researches were fruitful, and during the two years of his research fellowship he had published papers on the influence of age and sex on reasoning, on the effect of sex hormones on the performance of a learned response, and on their effect on the water content of tissues. Two further papers were about to be submitted for publication. Hanson's main contributions to knowledge were, first, the fact that œstrogens affect the performance of learned responses in rats, and secondly, that the phenomenon of insight which is occasionally observed in behavioural experiments on rats is largely a function of age and handling. An abstract of the opening paper given by Hanson to a symposium on "Aggression in Nature and Society" appears on p. 428 of this issue. Hanson's death at the age of twenty-five removes a scholar of exceptional promise and considerable charm. He leaves a widow and child.

S. ZUCKERMAN

WE regret to announce the following deaths:

Dr. James A. Bowie, principal of the Dundee School of Economics, on September 1.

Prof. S. H. Reynolds, emeritus professor of geology in the University of Bristol, on August 20, aged eighty-two.

NEWS and VIEWS

British Association: Presidents for 1950 and 1951

H.R.H. THE DUKE OF EDINBURGH has accepted the invitation to become president during 1951 of the British Association, when the annual meeting will be held in Edinburgh.

The announcement that Sir Harold Hartley has accepted the presidency of the British Association for 1950 will be received with general satisfaction. Sir Harold has already held high office in the Association, where his work has contributed so much to its great success. Educated at Dulwich College, where he came under the influence of that distinguished chemist, H. B. Baker, he showed at an early age an enthusiasm for chemistry. It was not surprising, therefore, that at Oxford he had a brilliant scientific career. For some thirty years he was associated with the Oxford School of Physical Chemistry, and that famous school of research and teaching now directed by Sir Hartley's former pupil, Sir Cyril Hinshelwood, owes much to Hartley's inspiration. The administrative achievements of Sir Harold Hartley are common knowledge. His flair for administration was given prominence during the First World War, in which he attained the rank of brigadier-general and became controller of the Chemical Warfare Department at the Ministry of Munitions. Since that time, among high administrative offices he has held with distinction, are the vice-presidency and directorship of research for the L.M.S. Railway, 1930–45, and the chairmanship of the British Overseas Airways Corporation, which he relinquished recently. In emphasizing his outstanding success as a scientific investigator and an administrator, his great interest in the arts must not be overlooked. Books and pictures are vital matters to him. As a lecturer he is in great demand on important national and international occasions.

Physical Society's Awards: Dr. G. M. B. Dobson, F.R.S.

THE Physical Society has awarded its Charles Chree Medal and Prize for 1949 to Dr. G. M. B. Dobson for his work on physical meteorology. Dr. Dobson is one of Britain's outstanding physical meteorologists whose researches have been chiefly concerned with the physics of the upper air. He has designed and used two instruments of outstanding importance in meteorological work. The first, an electronically operated recording double spectrometer for measuring the amount of ozone in the upper atmosphere, is now in use all over the world and is of great importance. The second, an automatic photo-electric hygrometer for use in high-altitude flights, was used with great success during the War, and has recently been described in the *Proceedings of the Physical Society*. Dr. Dobson has obtained very interesting and unexpected results with this instrument, which has solved one of the outstanding instrumental problems of meteorology. Dr. Dobson will receive the Medal and will describe his work at a meeting of the Society on November 4.

Dr. A. J. Guinier

THE 1949 Charles Vernon Boys Prize has been awarded to Dr. A. J. Guinier. Dr. Guinier's principal researches have been concerned with problems of

small crystallite size and shape, crystal texture and imperfections of crystal lattices. In order to facilitate this work he has constructed two powerful X-ray generators, with copper–copper oxide rectifiers; and has experimented in the production of a very fine focus in his X-ray tubes. He has also made and cut curved quartz crystal monochromators, by means of which a powerful focused monochromatic beam of molybdenum or copper K radiation can be obtained, and he has used these to investigate the small-angle scattering from catalysts, colloids and the lamellæ produced during the age-hardening of alloys. He has studied the non-Laue scattering associated with age-hardening and order–disorder phenomena in various alloys, defects of periodicity in fibrous structures, lattice deformations under mechanical stresses, and atomic movements associated with thermal vibration in crystal, the standard of his experimental work being uniformly high. He is now devising ingenious methods of wide- and narrow-beam Laue photography for the investigation of twinned and distorted crystals. It is hoped that Dr. Guinier may receive the Prize during his visit to England in November.

Botany at the Royal Holloway College, London: Dr. F. W. Jane

Dr. F. W. Jane, who has recently been appointed to the newly created chair of botany at the Royal Holloway College, London, has accordingly resigned the readership in botany which he held at University College, London. Dr. Jane's scientific work has been noteworthy for the variety of its interest. It has dealt particularly with the smaller algæ and with the structure and properties of wood. He has considerably enlarged our knowledge of the Chrysomonadineæ and Volvocales, as well as promoting research among other algal types and more recently in algal ecology. His interest in wood has centred on its structural properties and on problems associated with timber utilization. Dr. Jane recently visited West Africa to study certain forest areas and timber trees in the Gold Coast, and he has conducted courses on the structure and properties of timber and cognate subjects at London, Oxford and Cambridge for the Timber Development Association's new national education scheme. Dr. Jane is widely known outside university circles in the vicinity of London as one of the leading all-round naturalists, possessing a detailed knowledge of birds and beasts which rivals his interest in field botany. He has long been editor of the *Transactions of the Hertfordshire Natural History Society* and was also president of the Essex Field Club. He has taken a great interest in Blakeney Point, Norfolk, where he has been supervising and continuing the work started at the field laboratory by Prof. F. W. Oliver.

Chelsea Polytechnic: Dr. F. J. Harlow, M.B.E.

Dr. F. J. Harlow is retiring after twenty-one years as principal of the Chelsea Polytechnic, London, to which post he was appointed from the Wigan Technical College. Throughout his service at Chelsea, Dr. Harlow has taken a lively interest in matters concerning education generally and technical education in particular. He has held high office in the Association of Technical Institutions and the Association of Principals of Technical Institutions, and has served on most of the important committees of these associations. During his time at Chelsea the Polytechnic has made marked progress and ranks at present as one of the most important technical institutions in the country. Its association with the University of London is particularly strong, as evidenced by the large number of internal students and the number of higher degrees which are gained annually.

Mr. N. M. H. Lightfoot

Mr. N. M. H. Lightfoot has been appointed to succeed Dr. Harlow as from January 1, 1950. He is the present principal of the South-East Essex Technical College and School of Art, Dagenham, Essex, to which post he was appointed after service as lecturer in mathematics in the Universities of Manchester and Sheffield and the Heriot-Wade College, Edinburgh. At the Heriot-Wade College he was head of the Mathematics Department for five years prior to his principalship at Dagenham.

Equipment for γ-Radiography

With the increasing use of γ-radiography for the inspection of metal castings, forgings, and welds, attention has been rightly directed to the necessity of providing adequate protection for personnel against excessive exposure to γ-radiation. This is somewhat more difficult to achieve with portable γ-ray sources than with permanent X-ray installations, and a need has long been felt for a well-designed protective carrier and exposure unit for use with radium or radon. The announcement that Johnson Matthey and Co., Ltd., are manufacturing protective equipment for industrial radiography is therefore welcome. The basic unit is a portable carrier, constructed of copper tungsten alloy so as to provide adequate screenage for sources up to 250 millicuries. The beam may be directed accurately and safely with the aid of a periscopic device, and the unit is conveniently mounted on a mobile stand. For taking panoramic radiographs of a number of objects simultaneously, a time-controlled exposure unit is available. Although equipment of this kind cannot absolve the user from taking the routine precautions which are necessary for all radiation work, the Johnson Matthey units, which are clearly the result of considerable experience of industrial radiography, will certainly make his task easier; with them there should be no difficulty in complying with accepted protection standards. They will assist the industrial radiologist to take advantage of the improved supplies of radium and radon which are now available (*Nature*, June 4, 1949, p. 867).

The World Health Organisation

During its first year of work the efforts of the World Health Organisation were concentrated on the organisation of control-measures against malaria, tuberculosis and venereal diseases, on the improvement of maternal and child health and of environmental hygiene, and on problems relating to nutrition. These, and other activities such as international epidemiology, biological standardization and the unification of pharmacopoeias, were decided at the meetings of the First World Health Assembly and have been reported in previous issues of the *Chronicle of the World Health Organisation*. In the latest issue of the *Chronicle* (3, No. 4; April 1949) an account is given of the preparations made for the Second World Health Assembly to be held in Rome. This forecasts increasing activities by the World Health Organisation to combat the ravages wrought by pest diseases in many countries of the world and to tackle the general health problems of under-developed

countries. In 1949 the estimated budget of the Organisation is 7,000,000 dollars; in 1950 it is proposed to spend 17,000,000 dollars. This would be made up of a regular budget of less than 8,000,000 dollars to be financed by contributions from member states and a supplemental operating programme of technical and advisory services costing a little more than 9,000,000 dollars which would be financed by voluntary additional contributions to the World Health Organisation from member states. The latter programme would cover new health projects and extend the range of the existing programme. Details of the new projects and other activities of the Organisation are described in the *Chronicle* which is published monthly in English, French, Russian, Spanish and Chinese.

Fuzz-Hairs of Cotton-Seed

MR. O. M. ABDELHAFEZ, of the Fouad I Agricultural Museum, Dokki, Cairo, writes that when examining 'neps' taken from cotton yarn it was noticed that fuzz-hairs attached to testa fragments kept such stains as Iodine Green after washing, while the lint-hairs lost the colour. Microtome sections of ovules stained with Methyl Green and Congo Red showed fuzz-hairs beginning to form on the fifth day after flowering, with blue or violet cytoplasm which contrasted sharply with the five-day-old lint-hairs, the walls of which were red. No fuzz-hairs were observed earlier than this.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. Joseph Rotblat, to the University chair of physics tenable at St. Bartholomew's Hospital Medical College, from January 1, 1950; Dr. A. C. Cunliffe, to the University readership in bacteriology tenable at King's College Hospital Medical School, from October 1, 1949; Mr. J. L. Malcolm, to the University readership in experimental physiology tenable at St. Mary's Hospital Medical School, from October 1, 1949.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: T. J. L. Bates, agricultural officer, Tanganyika; J. J. Davies, agricultural officer, Tanganyika; D. J. McCrae, entomologist, Kenya; N. E. S. Mutter, agricultural officer, Tanganyika; D. G. Cooper, assistant electrical engineer, Public Works Department, Nyasaland; F. Hobgood, geologist, Nyasaland; D. N. Sampson, geologist, Tanganyika; A. O. Stickings, surveyor, Sarawak; T. Pettifer, veterinary officer, Tanganyika; D. A. Walker, veterinary officer, Kenya; D. F. Bargman, meteorologist, East African High Commission; W. L. D. Diaper, government chemist, Mauritius; I. G. Mathers, agricultural development officer, Nigeria; Miss J. Tyrell, statistical officer, Nigeria; M. Akenhead (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; J. A. Allan (pasture research officer, Kenya), agricultural officer, Northern Rhodesia; J. Cofie (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; M. Halcrow (deputy director of agriculture, Barbados), deputy director of agriculture, Nyasaland; J. H. Hinds (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; A. Jones (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; C. J. McK. Krige (agricultural officer, Somaliland Protectorate), senior agricultural officer, Northern Rhodesia; F. R. B. Mullan (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; T. A. Phillips (agricultural officer, Nigeria), principal of schools, Agricultural Department, Nigeria; R. Smith (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; G. R. Spurrell (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; J. O. Torto (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; S. G. Willimott (chemist (soils), Agricultural Department, Federation of Malaya), senior chemist (soils), Agricultural Department, Federation of Malaya; M. W. Bryce (executive engineer, Nigeria), assistant director, Water Supply Department, Gold Coast; D. H. Lawson (senior executive engineer, Nigeria), deputy director of public works, Kenya; C. E. Prockter (senior electrical engineer, Gold Coast), senior electrical engineer, Nigeria; G. G. K. Setten (assistant conservator of forests, Fiji), assistant conservator of forests, Federation of Malaya; G. F. Elliott (senior veterinary officer, Northern Rhodesia), deputy director of veterinary services, Northern Rhodesia; E. F. Peck (chief veterinary officer, Somaliland Protectorate), director, combined agricultural and veterinary services, Somaliland Protectorate; M. H. French (biochemist, Veterinary Department, Tanganyika), adviser to the Hides, Tanning and Allied Industries Bureau, East Africa High Commission; C. E. W. Hoar (pathologist, Grade B, Trinidad), pathologist, Nigeria; C. J. P. Ionides (game ranger, Tanganyika), senior game ranger, Tanganyika; D. K. Thomas (veterinary officer, Tanganyika), game ranger, Game Department, Tanganyika.

Announcements

AT the inaugural meeting of the British Association at Newcastle upon Tyne on August 31, the honorary degree of D.Sc. of the University of Durham was conferred on Sir John Russell, president of the Association.

MR. F. BRUNDRETT, chief of the Royal Naval Scientific Service, has been appointed to succeed Sir Edward Appleton as chairman of the Interdepartmental Scientific Panel set up in 1946 under the White Paper on the Scientific Civil Service.

IN connexion with the Goethe bicentenary celebrations, an exhibition illustrating the views of Goethe on plant metamorphosis and on colour has been arranged by the Goethean Science Foundation, Clent, Stourbridge, Worcestershire, and will be open at the Rudolf Steiner House, 35 Park Road, Baker Street, London, N.W.1, during September 15–24.

TO promote and encourage scientific and technical research in connexion with the textile industry, the Textile Institute is offering a limited number of research studentships to holders of the associateship of the Institute who are employed in the teaching or practice of textile technology, and to members qualified to undertake research, generally on a part-time basis, at approved universities and colleges. Further particulars are available from the Textile Institute, 16 St. Mary's Parsonage, Manchester 3.

ERRATUM. In the article "Effect of Low Temperature on the Absorption Spectra of Hæmoproteins; with Observations on the Absorption Spectrum of Oxygen", *Nature*, August 13, p. 258, the position of the second band of oxygen should read 577 mμ throughout and not 557 mμ.

EXISTENCE OF NITROSYL IONS (NO^+) IN DINITROGEN TETROXIDE AND OF NITRONIUM IONS (NO_2^+) IN LIQUID DINITROGEN PENTOXIDE

By Dr. W. ROGIE ANGUS, RICHARD W. JONES
AND
GLYN O. PHILLIPS
University College of North Wales, Bangor

THE Nitrosyl Ion. A few months ago, Addison and Thompson[1] published a preliminary account of certain reactions which they had carried out in liquid dinitrogen tetroxide and concluded that "where electron transfer can readily occur . . . reactions . . . can be interpreted on the basis of the ionization: $N_2O_4 \rightleftharpoons NO^+ + NO_3^-$". One of us has already adduced experimental evidence for the existence of the nitrosyl (NO^+) ion in certain compounds[2] and, consequently, was prompted by Addison and Thompson's work to explore the possibility of establishing the existence of NO^+ in liquid dinitrogen tetroxide or, alternatively, of establishing the conditions conducive to the production of this ion.

The reactions described by Addison and Thompson do not preclude the possibility of liquid dinitrogen tetroxide containing NO^+ ions. If, indeed, this were so, determination of the molecular weight of dinitrogen tetroxide in glacial acetic acid should yield abnormal values; we have confirmed experimentally (by the cryoscopic method) that no such abnormalities are encountered. Further, if liquid dinitrogen tetroxide contains NO^+ ions, it should be electrolysable. Following the technique used by Angus and Leckie[3], electrolysis of liquid dinitrogen tetroxide between an iron cathode and a platinum anode, with a potential difference of 230 volts, gave no trace of formation of the characteristically coloured $Fe(NO)^{++}$ ion in the cathode arm. We feel convinced, therefore, that *liquid* dinitrogen tetroxide does not exist, even partially, in the ionized form, $NO^+NO_3^-$.

It becomes necessary, therefore, to postulate in liquid dinitrogen tetroxide the existence of a state which will not be in conflict with any of the ascertained data. We believe that the existence of the molecule in the polarized condition represented by $\overset{\delta+}{NO}—\overset{\delta-}{NO_2}$ fulfils all the requirements, basing our belief on a variety of experimental evidence, part of which will now be summarized. Such a polarization would have as its limiting state the formation of NO^+ and NO_3^- ions. Consequently, under the influence of strongly polarizing agencies, this ionization would be caused to occur.

We adduce the following experimental evidence in support of this contention:

(*a*) Electrolysis of a solution of liquid dinitrogen tetroxide in glacial acetic acid between an iron cathode and a platinum anode (p.d. 230 volts) occurred only after addition of a crystal of sodium acetate, and was characterized by rapid evolution of gases at the electrodes and the appearance of the 'brown ring' colour around the cathode. This brown coloration was swiftly dispersed unless precautions were taken to diminish the current and so reduce the vigour with which gases were evolved. With a current of 0·3 amp. the brown colour could be 'fixed' in the cathode arm. The applied potential difference would thus appear to facilitate the ionization of the polarized condition $\overset{\delta+}{NO}—\overset{\delta-}{NO_2}$, and, on migration to the cathode, NO^+ ions are able, after discharge, to combine with ferrous ions to yield brown $Fe(NO)^{++}$ ions.

(*b*) We have confirmed the findings of Addison and Thompson in respect of the reaction between sodium and liquid dinitrogen tetroxide. Crystallographic analysis (kindly carried out for us by Dr. N. H. Hartshorne) has revealed that the white solid product consists entirely of crystals of sodium nitrate. Addison and Thompson have noted the diminished vigour of this reaction when benzene is added. We find that the application of a potential difference while the reaction is taking place brings about a very marked increase in the speed. All these results may be interpreted on the basis of the postulated polarized state of liquid dinitrogen tetroxide.

(*c*) Liquid dinitrogen tetroxide reacts immediately with thionyl chloride and yields nitrosyl chloride in isolatable quantity. Addition of liquid sulphur dioxide markedly enhances the yield of nitrosyl chloride.

From these observations we infer that at the moment of reaction the ions NO^+ and NO_3^- are available to react, and that these arise from molecules in an $\overset{\delta+}{NO}—\overset{\delta-}{NO_2}$ state of polarization.

The Nitronium Ion. The nitronium ion (NO_2^+) has been postulated to exist in solutions of nitric acid in sulphuric acid, in solutions of dinitrogen pentoxide in nitric acid, in solutions of nitric acid in sulphuric oleum, and in concentrated aqueous solutions of dinitrogen pentoxide. Cryoscopic measurements on solutions of nitric acid in sulphuric acid or in sulphuric oleum yield van't Hoff *i* factors which are only consistent with ionizations involving production of nitronium ions. Other evidence accrues from consideration of a polarized Raman frequency of approximately 1,400 cm.$^{-1}$, which is exhibited in the systems mentioned above and in some others where NO_2X compounds are likely to be formed, for example, NO_2ClO_4 or NO_2HSeO_4. This frequency has been considered to be uniquely associated with the nitronium ion. A summary and bibliography relating to these lines of evidence are contained in the recent review by Gillespie and Millen[3].

We have been able recently to demonstrate the existence of the nitronium ion in dinitrogen pentoxide by a more direct method. Although our observations are as yet only on a qualitative basis, we consider the evidence to be sufficiently convincing to merit a brief note. The evidence which we have produced above for the existence of dinitrogen tetroxide molecules in the $\overset{\delta+}{NO}—\overset{\delta-}{NO_2}$ state pointed strongly to the probability that the analogous $\overset{\delta+}{NO_2}—\overset{\delta-}{NO_2}$ state should

exist in liquid dinitrogen pentoxide. It is not possible, however, with the higher oxide, to invoke the aid of visually discernible electrolytic effects. But a strikingly significant reaction occurs when small pieces of clean sodium are added at −40° to liquid dinitrogen pentoxide (obtained as a straw-coloured liquid by melting almost colourless crystals of the oxide). The reaction takes place with very great vigour—much more vigorously than the corresponding reaction with liquid dinitrogen tetroxide; there is copious evolution of brown fumes of nitrogen dioxide and a white crystalline solid remains, which on isolation has been identified as sodium nitrate by ordinary analytical and by crystallographic tests. For sodium nitrate to be formed under these conditions, it is necessary to postulate the existence or the prior formation of nitrate ions in the pentoxide. This, it is submitted, could result from the polarized $\overset{\delta+}{NO_2}—\overset{\delta-}{NO_3}$ molecule becoming ionized to NO_3^+ and NO_2^- under the agency of the sodium. It cannot, however, be affirmed unequivocally what the state of the molecule in liquid dinitrogen pentoxide is until further work along a variety of lines has been undertaken. Nevertheless, the observation does give strong confirmation to the deductions from cryoscopic and Raman spectral measurements.

Detailed discussion of the significance of these observations will be given later elsewhere.

[1] Addison, C. C., and Thompson, R., *Nature*, **162**, 369 (1948).
[2] Angus, W. R., and Leckie, A. H., *Trans. Farad. Soc.*, **31**, 958 (1935).
[3] Gillespie, R. J., and Millen, D. J., *Quart. Rev.*, **2**, 277 (1948).

REFINING OF NON-FERROUS METALS

A SYMPOSIUM on the refining of non-ferrous metals, organised by the Institution of Mining and Metallurgy, took place on July 7–8, 1949, at the Institution of Mechanical Engineers, Storey's Gate, London. The programme of nineteen papers ranged over all classes of metals—base, precious, light, semi-rare and rare—and was arranged in four sessions at which the chairmen were Mr. W. A. C. Newman (president of the Institution), Sir Arthur Smout, Sir Paul Gueterbock and Prof. C. W. Dannatt. In the following brief summary of the proceedings the papers are, for convenience, grouped somewhat differently from the sessional order.

Three papers were devoted to copper. H. J. Miller discussed very fully the development of fire refining, giving the details of the process and the reactions involved, the paper being made the more complete by treatment not only of the removal of impurities, but also of the influence of impurities on the properties of copper and of the casting of refined copper products. While mainly concerned with the reverberatory furnace process, the use of rotary furnaces was described and illustrated, and reference was made to direct arc and induction furnace methods in use in North America. R. H. Bauld's paper on melting and casting of high-conductivity wire bars was particularly interesting, because it discussed the attempts made to depart from the traditional method of reverberatory furnace refining followed by casting on wheels with horizontal moulds open to the atmosphere. Mr. Bauld only mentioned this method briefly, and then went on to discuss the production of oxygen-free high-conductivity copper at Carteret and the direct furnace melting of cathodes as pioneered by the Ontario Refining Co. The casting of vertical instead of horizontal bars was dealt with, and the final section of the paper was concerned with continuous casting, both by the Welblund-Benard machine at Carteret and the new installation, by the United States Metals Refining Co., of a Junghans-Rossi machine for casting round or rectangular sections. This description was particularly valuable because it dealt with a process the products of which are only just coming on to the market. The third of the papers on copper (by W. J. Friggens, E. W. Page and T. Milligan) described in detail the new electrolytic copper refinery at Nkana. This is on traditional and somewhat conservative lines.

Providing as they did factual information on the processes carried out and plant used, the copper papers did not lend themselves well to discussion; but an immense amount of useful data was compressed into these three contributions, which between them give a good up-to-date picture of the refining and casting of copper.

The paper on lead refining at Port Pirie, South Australia, by Mr. F. A. Green, dealt with what was described by Sir Paul Gueterbock (the chairman) as one of the most remarkable metallurgical processes in the world. In this, the Williams continuous lead-refining process, base lead bullion is treated for successive removal of copper (by drossing and sulphur treatment), arsenic and antimony (by oxidation), silver (by zinc), and finally removal of the zinc used in desilvering. In the lively discussion which followed, one speaker wondered whether the liquid layer parts of the method had been influenced by the Harris process of lead refining, which perhaps had not received the general appreciation it deserved. Others drew an analogy between the oxidation of the arsenic and antimony in the softening process, and certain oxidation phenomena in steel production. Mr. S. B. Haney (who presented the paper on lead on behalf of the author) indicated in answer to various comments that the price of chlorine is a barrier to its use for the removal of zinc remaining after desilverization; nevertheless the idea is being kept in mind. He also disclosed that latterly his company had been investigating the removal of zinc from lead by vacuum distillation, as developed by Isbell of the St. Joseph Lead Co. This interesting process is being applied by the Company to 100-ton batches of lead; by the American Smelting and Refining Co. in 200-ton kettles with 180 tons intake; while at Port Pirie 100-ton batches of desilverized lead with 0·56 per cent of zinc are being treated.

At the same session as the paper on lead, zinc and tin were discussed. Mr. Stanley Robson's paper on zinc refining was a concise account of the various stages in the development of zinc metallurgy. Horizontal retort distillation was the original method. Some purification is effected by liquation of the product (this permits of reduction of the lead content to 1 per cent). Another method of increasing the purity is insertion of a filter-plug between retort and condenser, this idea being further tried in the redistillation of zinc metal. Finally, Peirce and his associates of New Jersey have developed fractional distillation of zinc in vertical retorts. This latter method brilliantly solves the problem of purification by distillation, giving a zinc of 99·996 per cent purity (less than 0·001 per cent lead and 0·002 per cent iron), using units treating 50–60 tons per day. Brief reference was made to electrolytic zinc refining. Mr.

E. H. Jones's paper on tin reviewed the properties of the metal and its compounds which determine the refining methods used, and described at some length the principles and operation of a large number of available processes. He emphasized that the particular combination of methods used at any one refining plant is chosen largely on grounds of flexibility, since batches of ore and secondary metal of widely varying composition might be handled.

Of the two contributions on precious metals, that by Mr. A. E. Richards was a wide survey of methods of refining gold and silver. In his introductory remarks he stressed the importance of correct sampling of refinable bullion, particularly if the bullion is of comparatively low grade; as well as the necessity for speed in refining, owing to the value of the material, which might be subject to market fluctuations. This factor of value also bears on the choice of the refining process. Mr. H. Gordon Dale's paper was, on the other hand, concerned with the recovery of precious metals in general from residues and wastes in the industry. He likewise underlined the importance of correct assaying and sampling, particularly in the case of 'sweeps', which are often of a complex and varied nature. In the discussion of these papers, reference was made to the virtual extinction of the 'Wohlwill' gold-refining process, and to the present use of chlorine for refining the bulk of the gold in the world. The latter, however, yields a product which is troublesome in mechanical treatment, so that most gold used by jewellers is chlorine-refined material which has been re-refined. Mr. Richards agreed that the use of the chlorine process on a larger scale is a future possibility.

The light metals were the subject of three papers. Mr. E. F. Emley, introducing his paper on magnesium refining, mentioned that the preparation of satisfactory castings and other products free from non-metallic inclusions of oxide and flux residues has necessitated the development of special flux treatments to clean the molten metal. The action of these cleaning fluxes has been thoroughly investigated. The true refining processes in which, by flux action or by precipitation, metallic impurities are removed from magnesium, have been less completely investigated, and fundamental thermodynamic data applicable to the flux-refining process are lacking. In the discussion, Dr. P. Gross expressed surprise that the refining of magnesium by vacuum distillation, a less difficult operation than might be supposed, has not received wider application.

The electronegative character of aluminium, and special difficulties associated with direct distillation processes, are the reasons why present commercial refining methods for this metal depend on the electrolysis of a fused salt mixture. Such processes require large amounts of electrical energy and are therefore expensive. In bringing forward his paper on aluminium refining, Mr. J. Waddington remarked that the development of a satisfactory physical refining process for aluminium would completely change the aluminium industry. Not only would it facilitate the refining of scrap metal, but also the existence of such a process would enable impure metal from the reduction of unpurified bauxite to be brought to normal standards of commercial purity. The "Catalytic Distillation of Aluminium", by Dr. P. Gross, the third paper of the group, described a physical refining process in course of development. Under suitable conditions, aluminium trichloride can be made to react with molten aluminium to form unstable aluminium monochloride, this reverting on cooling to trichloride vapour and metallic aluminium which condenses. Volatile impurities, zinc or magnesium, will distil with the aluminium, and have first to be removed by vacuum heating. Iron and silicon, however, have negligible vapour pressures at the temperatures at which catalytic distillation of aluminium is possible.

The group of materials comprising ferro-alloys, chromium, manganese, etc., was covered in two papers. In dealing with "The Alumino-Thermic Process", Mr. T. Burchell, after a general description, discussed in detail the preparation of commercially pure chromium, manganese and ferro-columbium. He mentioned the lack of adequate data on the thermochemical considerations governing these reactions, which actually occur in solid, liquid and gaseous phases. In the subsequent discussion the opinion was put forward that lower oxides of aluminium, such as the suboxide Al_2O, may play a more important part in the reaction than had been thought. For example, the attack of aluminium vapour on alumina films on aluminium particles to give a volatile suboxide may explain the great acceleration of these reactions. Mr. Burchell, however, considered that the reaction is more likely to be accelerated by decomposition of oxides by heat. Mr. J. A. Blake, presenting a paper on "Low-carbon Ferro Chrome", described the production of material to meet requirements of a ferro-alloy for the production of stainless steel. The process is designed to eliminate carbon by making use of the greater affinity of chromium for silicon. It is worked in two stages, and in reply to a suggestion that theoretically it should be possible to work a one-stage process, the author said that in practice this had not been found feasible.

Of the remaining papers, two were by Mr. A. R. Powell. In "Problems in the Production of Some of the Rarer Metals", he touched briefly on gallium, germanium, indium, thallium, rhenium and various others. He pointed out in his introductory remarks that the properties of some of these metals in the purest state are not known, owing to the difficulties presented in their production. The removal of metallic impurities is comparatively simple; but the metals easily form oxides, hydrides or nitrides, the presence of which has a considerable effect on properties. In reply to the discussion the author said that a suitable refractory for use in refining is thoria, which, however, is expensive: there are possibilities in lime or baryta crucibles. Mr. Powell's second paper dealt with the refining of bismuth, by essentially metallurgical methods, including its recovery from copper and lead, treatment of the rich bismuth–lead alloy, desilverization, and removal of zinc and lead, with finally a brief account of the equipment and operation of a small refinery.

"Tungsten: its Preparation and Use in Electronics and Carbide Products" was presented by Mr. F. Smeaton, who covered production by ordinary wet methods from ore and scrap. There was some discussion of the mechanism of the reduction of tungstic oxide by hydrogen and of the part played by water vapour in the reaction. Mr. P. S. Bryant described the production of cobalt (by a wet chemical method culminating in reduction of the oxide by hydrogen), using as raw material a granulated alloy of cobalt, copper and iron arising from the treatment of converter slags from a Rhodesian copper refinery.

Dr. G. L. Miller dealt with the production of ductile zirconium, including the van Arkel iodide method of

purifying the crude metal and the Kroll process, consisting of preparation of the chloride and its reduction by magnesium. He looked forward to elimination of the intermediate production of crude metal in the iodide process, and to a continuous iodide process with a travelling filament. In the discussion mention was made of the possibility of thermal reduction of zirconium chloride with hydrogen, a method which has been used in Germany for titanium.

Finally, it remains to mention a paper on spectrographic control in metal refining, in which Mr. D. M. Smith outlined factors affecting choice of technique and detail of method. Mention was made of the complementary nature of chemical and spectrographic methods of analysis, and this aspect also received attention in the discussion.

Over such a wide field (in some of which relatively few people are experienced) the amount of discussion was naturally variable, but those who attended had an opportunity, which can only rarely be repeated, of hearing about the refining of a large variety of metals from the actual practitioners. It is to be hoped that the complete record of the proceedings will be published as soon as possible, for it will form an authoritative account of modern practice in a most important branch of industry.

SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

THE twenty-second annual report of the Department of Scientific and Industrial Research, New Zealand, covering the year 1947–48, is much less detailed than previous reports, although the activities of the Department have expanded during the year, to meet the marked increase in the immediate demands for scientific assistance from State departments and industry and in an attempt to anticipate the scientific needs of the next decade. Both the accompanying Minister's Statement and the Secretary's report refer to difficulties experienced through the limited number of qualified scientific workers, as well as through lack of suitable accommodation. Nevertheless, arrangements have been made for officers to take courses of studies in overseas institutions and to attend scientific conferences abroad. Increased collaboration between various branches of the Department and with other State departments has diminished the handicaps of shortage of staff and accommodation. Besides the formation of a Hop Research Association, a Leather and Footwear Research Association, which will extend the scope of the existing Leather Research Association, was formed during the year.

Regional soil surveys have been completed over extensive areas in South Island, and more extensive surveys undertaken for special purposes in North Island. Pasture research has been extended to hill-country areas and intensified on flat country, while progress is reported in pasture-management research and in the understanding of the nutrition requirements of ordinary pastures. The new wheat variety, "Hilgendorf" has provided the Dominion with a grain of exceptionally high protein quality with no loss of yield. A comprehensive study of frost damage has been inaugurated in fruit and horticultural crop areas, while soil and manurial investigations are assisting in the extension of the tobacco crop and improving its yield. Chemical studies of tobacco leaf correlated with quality tests are throwing much light on the smoking quality of New Zealand-grown tobacco; much useful new knowledge has also been gained on the propagation and management of the native fibre plant *Phormium*, the source of New Zealand flax.

Arrangements have almost been completed for establishing, under Canterbury University College, an Industrial Development Department which will provide service, development and research for South Island manufacturers. Extensive geophysical surveys have been carried out for the State Hydro-electric Department in connexion with foundation studies for the construction of dams on the Waikato River. A feature of the work of the soil physics section of the Soil Bureau has been investigations of foundations for large buildings, factories, mills, earth dams and tanks. The fruit research activities of the Department have been reorganised and consolidated into a branch under a director, and special attention has been given to research problems affecting building and civil engineering.

An investigation on anomalous radar propagation carried out jointly by the United Kingdom and New Zealand Governments at Ashburton concluded its field work. The Plant Chemistry Laboratory and the Dominion Laboratory have installed a plant for the preparation of antibiotic substances and small amounts of penicillin have been made. Further points from the reports of the research committees which may be mentioned include the establishment of an Aeronautical Research Committee; the recommendation, as a result of biological tests on their toxicity against insects by the Plant Diseases Division, of six chemicals and proprietary mixtures for use as timber preservatives; further work on the refrigerated gas storage of apples; and trials of D.D.T. sprays both for their effect on the cold-storage quality of apples and for control of codling moth.

The Industrial Psychology Division commenced a survey of the present trend towards decentralization in New Zealand industry and investigated the use of psychological techniques for selecting personnel in some of the skilled ground-staff grades of the Royal New Zealand Air Force. At the Cawthron Institute, studies on tomato soils and on the incidence of 'cloud' in Nelson tomato-houses continued, while at Canterbury Agricultural College the fungus responsible for prevalent foliage disease of field and garden peas was isolated and studied. In the Agronomy Division, 'Agroxone' has replaced 'Sinox' for routine spraying of nucleus-seed crops of linen flax and linseed for control of weeds.

SCIENCE MASTERS' ASSOCIATION

SUMMER MEETING

BY kind permission of the Admiralty and of Rear-Admiral H. W. Faulkner, and on the invitation of the head master and staff, the Science Masters' Association held a summer course on "Science and Sea Problems" at the Royal Naval College, Dartmouth, during the first week of August. The course consisted of lectures by some of the leading members of the Royal Naval Scientific Service and of displays of experimental work both by members of the College and by the general members of the Association. In addition, visits were paid to the Royal Naval

Engineering College at Keyham and Manadon and also to the Marine Biological Laboratory at Plymouth.

Of the lectures delivered, the following deserve particular mention. A lecture on radio aids to navigation, given by C. E. Horton, of the Royal Naval Scientific Service, described in detail the methods of plotting positions by bearings and by distances, stressing the degree of accuracy obtained up to the present with the apparatus available and the need for international agreement upon the systems to be used, impinging as this does upon national prestige, having an economic as well as a purely scientific aspect.

Dr. R. H. Purcell sought to commend the chemical side of the research carried out by the R.N.S.S. in the hope that the science masters present would foster in their pupils a desire to pursue special and fundamental chemical research for the Navy. Dr. Purcell illustrated the work of his department by a detailed examination of a problem taken from each of three of his seven departments. The first problem dealt with was that of evaporation. Many of His Majesty's ships require as much as fifteen to twenty tons of distilled water an hour. The problem of evaporating the necessary amount of sea water and the subsequent condensation of the steam is thus of outstanding importance. Hitherto the insoluble—in both senses—problem has been the formation of scale upon the copper tubing which, bonding with the copper into a hard scale, has defied all attempts at removal, has increased the ship's consumption of fuel and has necessitated the frequent renewal of the evaporator tubing. As a result of the work of the Department, a surface agent, 'Belloid', together with sodium polyphosphates, has been found to precipitate the dissolved sea water salts in such a way as to form a friable layer, easily removed from the evaporator tubing. As a consequence, there has been a 2 per cent saving in the oil consumption in some of the ships of the Royal Navy. A second problem dealt with was that of the preparation of perfect crystals for radio. These crystals are flawless, free from strain and occlusions. The details for their preparation were given and large crystals of ammonium dihydrogen phosphate and of lithium sulphate monohydrate were shown which excited amazement, being more than a foot long and nearly three inches square in cross-section. As the formation of such mammoth crystals could only be achieved by the use of substances whose maximum amount of impurities could not exceed twenty parts in a million, new techniques for the analysis of such minute amounts had to be devised. This aspect of the problem was dealt with later in the course by Dr. Ovenston.

A third problem dealt with by Dr. Purcell's department was an investigation into the properties of hydrogen peroxide of a purity of between 80–90 per cent. This substance, first used as a war material in the German glider bomb experiments in the Bay of Biscay experiments in 1943, provided most spectacular experiments when treated with suitable catalysts. Its use as a war material could be extensive, but in the wrong place or mixed with organic material it could be most unpleasant.

The problem of forecasting the nature of the surface of the ocean at any point was discussed by Dr. G. E. R. Deacon, when he described the work of the Wave Records Station on the coast of Cornwall. He showed how, by means of suitable pressure-recording apparatus, it was possible to obtain a wave spectrum by the examination of wave records and from these to trace the storms from which any particular set of waves, swells and surf had been generated. These observations have been co-ordinated with the micro-seismic oscillation which precede the passage of a storm towards the coast, and so the prediction of waves, swells and surf as they affect military or other landings can be made with great accuracy. Further, the changes as the waves enter tidal waters can be related to coastal and harbour engineering problems.

The Plymouth Marine Biological Laboratory supplied a most impressive display of marine animals, many of spectacular colouring. Mr. G. A. Stevens, from the Laboratory, described some of the problems which have, in recent times, been referred to the Laboratory for investigation. The first was a seal census of the Cornish coast with the subsequent modification of the protection orders for the great seal, to control the destruction of marketable fish due to the activities of these seals. The second was an investigation of the life migrations of the mackerel. Hitherto it has been assumed that spawning took place in the English Channel; but as a result of the investigations carried out by the Laboratory, it is now known that the mackerel spawns on the steep slopes of deep-water depressions far out in the Atlantic. The third problem still under investigation is the recession of certain types of pelagic fish-life from the English Channel, as, for example, the disappearance of herring shoals from the Channel. This lecture was followed the next day by a visit to the Laboratory in Plymouth.

The course concluded with a visit to the Royal Naval Engineering College at Keyham and its growing new home at Manadon, Plymouth. Here the courses for the commissioned engineers of the Navy were demonstrated and their relationship to the preceding grammar school science teaching explored.

On the return to Dartmouth, Lieut. Commander P. G. Satow dealt in detail with air currents, winds and storms, their detection and their influence upon radio recording instruments and thus upon the normal aids to navigation, especially in narrow waters, where extreme accuracy is essential. This lecture was illustrated by photographs and by reference to actual occurrences, such as the modern American air observation service which operates in the typhoon areas of the Atlantic and Pacific coasts with the object of avoiding catastrophes such as that which overtook three American destroyers in Eastern waters when, after a long engagement which left their oil tanks low, they were overtaken by a storm in which they heeled over with the loss of eight hundred men and all three vessels.

Throughout the course one was impressed by the gap between the popular fancy of the efficiency of directional aids and their actual performance. Even the most modern apparatus requires the most highly trained observer to translate the readings observed.

As the future entrants to Dartmouth will be almost exclusively those who have passed right through the public and the secondary grammar schools, this course, which enabled the masters in those schools to see the future work of some of their pupils, was most helpful and should ensure that the applications of biology, chemistry and physics to ocean problems are better understood, to the future greater comfort and safety of those who "go down to the sea in ships about their lawful occasions".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Action of Nitrogen Trichloride ('Agene') on Proteins: Isolation of Crystalline Toxic Factor

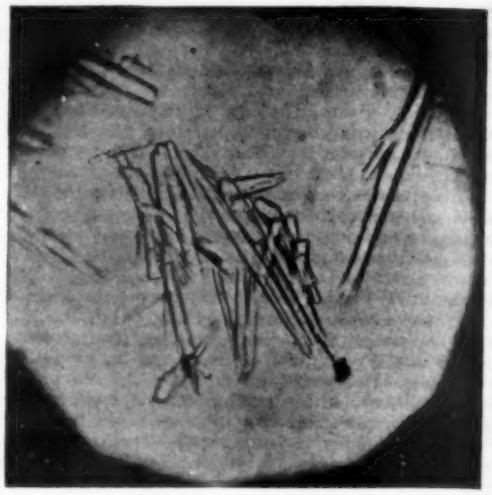
In a recent publication[1], we reported a considerable purification (approximately 2,500-fold) of the toxic factor from zein treated with nitrogen trichloride, which gives rise to convulsive fits in rabbits. As recorded, the best preparations were contaminated to an unknown extent with free amino-acids—proline, methionine and, as it now appears, probably histidine. Reiner *et al.*[2] and Butler and Mills[3] have also concentrated the toxic factor; but the degree of purification attained appears to be considerably less than that reported by us earlier[1].

Further purification has been made possible by accumulating material from several batches of 'agenized' zein and by certain modifications of the earlier procedure[1]. The principal modification is that, at the electrodialysis stage, in addition to working up the material from the mid-compartment of the cell, toxic material which has passed to the catholyte is now also recovered. This is done by returning the catholyte to the mid-compartment of the cell and electrodialysing again, while not allowing the *p*H of the mid-compartment to fall below *p*H 6·0. The material remaining in the mid-compartment of the cell is retained. This modification approximately doubles the recovery of toxic material, but a disadvantage is that more contaminating amino-acid material is also retained. Material from the cell is then applied, as before, to a resin exchange column, 'Zeo-Carb 215'. The new subsequent stages of purification are:

(1) The toxic fraction from the resin column is further fractionated by partition chromatography using kieselguhr as a supporting medium and phenol as developing solvent. Fractions from this column are examined by paper chromatography and the sequence in which ninhydrin-reacting substances appear is proline, methionine, material (*X*) having an R_F (phenol) of 0·71 (Whatman No. 1 paper has been used for all the chromatography referred to in this communication), and finally the group of substances of low R_F value noted previously. The important point is that the column separates proline, methionine and the low R_F substances completely from *X*. When the various fractions are fed to rabbits the toxicity is found only in *X*. This material when examined by paper chromatography gives a single spot using the following solvents: tertiary amyl alcohol, butanol – acetic acid, furfuryl alcohol, butanol, benzyl alcohol, phenol.

In collidine and aqueous acetone, however, it gives three distinct spots, one of which is due to histidine. It will be noted that the R_F in phenol is identical with that of histidine; further, the material when examined gives a positive Pauly reaction, confirming the presence of this amino-acid.

(2) The toxic fraction (*X*) from the kieselguhr column is applied to a small 'Zeo-Carb 215' column and then eluted with 0·15 *N* ammonia. The effluent is collected in small fractions and a micro *p*H determination made on each fraction. Early fractions give a *p*H of about 5·8; fractions of this *p*H continue for some time and then the *p*H rises sharply through *p*H 6·5 to *p*H 7·0. The fractions of *p*H 5·8 are combined (fraction *A*), as are those of *p*H 6·5 and over (fraction *B*). Fraction *A* gives a negative Pauly reaction, fraction *B* a positive reaction. On paper chromatograms fraction *A* gives a single spot in aqueous acetone and fraction *B* gives three spots, one of which is due to histidine and one identical with that from fraction *A*. Both fraction *A* and fraction *B* are found to be toxic to rabbits, with a greater concentration of toxic material in *A* compared with *B*.



Crystalline material from 'agenized' zein. × 350

From fraction *A* crystalline material (see photograph) is obtained by crystallization from aqueous ethanol. The crystalline material is toxic when fed to rabbits, and when examined by paper chromatography gives a single ninhydrin spot when run two ways in collidine and phenol. (Some comment on the reaction with ninhydrin is necessary. The crystalline material on filter paper gives with ninhydrin on heating a yellow colour turning through brown to purple only on further heating. This is probably one reason why we failed to detect it in our earlier work.)

We have found that material twice recrystallized from aqueous ethanol retains the same degree of toxicity. The needle-like crystals melt sharply with decomposition at 232° C. (uncorr.). A preliminary qualitative test has shown the crystals have an appreciable sulphur content. Further, we have prepared identical crystals from two separate batches of agenized zein. The melting point in each case is similar, the R_F values with paper chromatography are the same, as is the colour reaction with ninhydrin. A toxic dose (as defined previously[1]) of the crystals is of the order of 2 mgm.

Control. As a control we have used a batch of 'unagenized' zein in sufficient quantity to yield, had it been agenized, approximately a hundred toxic doses after the first 'Zeo-Carb 215' resin stage. This control zein has been put through all the purification stages. When the fractions from the kieselguhr column (using control zein) are examined by paper chromatography using phenol, the same apparent

sequence is observed, namely, proline, methionine, material of R_F 0·7 and material of low R_F, as when agenized zein is used. However, when the material of R_F 0·7 is applied to a small 'Zeo-Carb 215' column, the first fractions appearing are at *p*H 6·5, the characteristic ninhydrin colour given by the crystals is absent, the Pauly reaction is positive, that is, there is nothing present corresponding to fraction *A*.

Synge's[4] experience with gramicidin[4] has emphasized the difficulty of establishing the fact of homogeneity (even when crystalline) of substances of a peptide nature; this is particularly so when, as in the present case, only very small quantities of material are available.

At this stage we would record: (*a*) Crystalline material which produces convulsive fits in rabbits has been obtained from separate batches of 'agenized' zein; (*b*) the crystals from these batches have the same m.p. (232° C. uncorr.); (*c*) they show the same atypical ninhydrin reaction; (*d*) the toxicity is retained to the same degree on recrystallization; (*e*) corresponding material is entirely absent from 'unagenized' zein purified in precisely the same way.

H. R. Bentley
E. E. McDermott
J. Pace
J. K. Whitehead
T. Moran

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Cereals Research Station,
St. Albans.

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Toxic Effect of the Crystals from 'Agenized' Zein on Certain Acid-producing Bacteria

The crystalline material described above has been tested against several organisms used chiefly for microbiological assay. These tests have shown that the crystals are markedly toxic to the organism *Leuconostoc mesenteroides P*-60 at a concentration as low as 5 μgm. per ml. of liquid medium, the cells being agglutinated and acid production substantially reduced. With higher concentrations, of 50 μgm. per ml. or more, growth and acid-production are almost entirely suppressed. For this organism the limit for detecting a toxic effect is about 1–2 μgm. per ml. of medium. The following figures, observed after 16 hr. incubation on a full-growth medium at 37°, serve to illustrate the sensitivity of *Leuconostoc mesenteroides P*-60.

Concentration of crystalline material in full-growth medium (μgm./ml.)	Average titre (0·01*N* NaOH) ml.	Toxicity (extent of agglutination or diminution in numbers of bacteria)
Nil	2·11	Nil
1·3	1·99	T
5	1·46	T++
50	0·39	T++++++

Fractions toxic to rabbits at various stages in the preparation of the crystals have invariably been found to be toxic to *Leuconostoc mesenteroides P*-60.

With regard to other organisms, preliminary tests on *Lactobacillus arabinosus* 17/5 and on *Leuconostoc citrovorum* 8081 show that at concentrations of 50, and even of 100, μgm. per ml. the crystals exert no toxic effect. With *Lactobacillus fermentum* (36), *Lactobacillus helveticus* (*casei* ε) and *Streptococcus fæcalis* (*R*) there is a slight effect which can be detected at concentrations of 50 and 100 μgm. per ml.

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Structures of α-Keratin and Synthetic Polypeptides

The quest for the structure of the α-form of members of the keratin–myosin–epidermis–fibrinogen group of fibrous proteins has recently been encouraged by the discovery among X-ray photographs of synthetic polypeptides of a diffraction diagram that looks as if it might very well be of the α-type[1–5]. We have already given a preliminary discussion[1] of this possibility, and it naturally continues to engage our close attention; but we are not yet able to share the confidence of our fellow investigators[2–5] either in the genuineness of the supposed α-diagram or in the correctness of the intramolecular fold put forward to explain it. Having worked, with my colleagues, so long on the problem of the keratin–myosin–epidermis–fibrinogen group, I may be allowed to recall some of our earlier results and conclusions which have still not lost their force and which simply cannot be overlooked if we are to come finally to the right answer.

(1) The type of fold advocated by Ambrose and co-workers is the oldest in the history of the keratin–myosin–epidermis–fibrinogen group. It is a matter of twenty years since we first considered it, and an adaptation of it forms in fact the basis of our suggested collagen configuration[6]. We could not accept it for α-keratin chiefly because of the formidable objection on X-ray grounds. Such a fold, as it stands, would not give a strong meridional reflexion at about 5·1 A. unless light and heavy side-chains always alternated—and there is no evidence at all for that from the large variety of amino-acid compositions, both genuine α and supposed α, now in question. Rather should we expect a strong 'halving', as is found in the β-diagram.

(2) It is not sufficient to account for an extension of 35–40 per cent, when it is known that not only keratin fibres but also oriented myosin can show reversibility elasticity up to extensions of approximately 100 per cent. It is fallacious to argue that "the β-structure already appears at 30 per cent extension"[4], when what happens is that it becomes progressively stronger at higher extensions and when the indications are that the α–β transformation is a discontinuous process, the extension thus representing the proportion of chains that have been transformed; and it is shutting one's eyes to two-thirds of the issue (and, of course, ignoring myosin) to say that "changes in cellular structure and plastic flow may

also be involved in further extensions"[4]. The most reasonable inference from all sources of evidence is still that the 5·1 A. reflexion is associated with a repeat of three amino-acid residues, not two.

(3) It should not be forgotten that though the new diagram given by certain synthetic polypeptides certainly bears at first sight a strong resemblance to the α-diagram of the keratin–myosin–epidermis–fibrinogen group, detailed examination and measurement show that there are important differences to be reckoned with: not the least of these lies in the spacing of the dominant meridional arc, which is consistently round about 5·2$_5$ A. in the synthetic polypeptides but consistently round about 5·1$_5$ A. in the unstressed α-forms of the keratin–myosin–epidermis–fibrinogen group. I have not the slightest wish to reject the idea that the new polypeptide diagram may eventually turn out to be genuine α—indeed, I hope it will, for it would be a splendid advance in our understanding of the proteins—but surely we must beware of falling too readily into the habit of calling it an α-diagram and of drawing from these polypeptides conclusions about the structure of α-keratin before we have satisfied ourselves that they are in truth α-structures. There is an enormous gap yet between the amino-acid compositions and wonderful properties of the natural fibrous proteins and those of the synthetic products.

(4) The suggestion of Brown, Coleman and Farthing[3] is that the 5·2 A. spacing is the orthodox backbone spacing between extended polypeptide chains. This is quite untenable in face of the evidence that the latter, usually about 4·65 A. in the fibrous β-proteins, cannot in any event exceed about 4·77 A.[7].

(5) An observation of major interest in the communication from Bamford, Hanby and Happey[5], which has possibly passed unnoticed by the authors, is their finding the supposed α-diagram with fibres of poly-DL-phenyl-alanine, whereas we, working with a powder preparation[1], found a β-diagram. Thus we have now at least one synthetic polypeptide in two forms, the further investigation of which might help considerably towards settling the question whether one of them is really α.

(6) The infra-red situation is still far from comforting when it is looked at against the background of the many yet unexplained results given by synthetic polypeptides and fibrous proteins in general. Some of the difficulties are touched upon by Darmon and Sutherland in the accompanying letter.

One small final point which I may be forgiven for mentioning, and that is that the technique of stretching and orienting proteins and the like on thin films of rubber[6] is not new by any means. We have used it off and on for many years, and no doubt others have too.

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Evidence from Infra-Red Spectroscopy on the Structure of Proteins

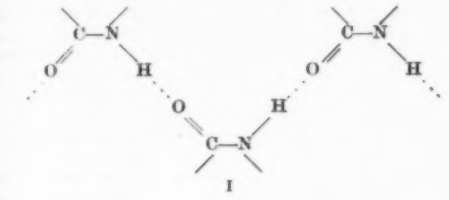
The infra-red absorption spectra of compounds containing the CO.NH peptide link, as observed by a number of investigators[1–3], frequently exhibit two bands in the region between 3,000 cm.$^{-1}$ and 3,400 cm.$^{-1}$, where NH-stretching frequencies may be expected. In the spectra of many amides and polyamides, nylon[3], and of certain proteins[3,4], there is a strong band near 3,280 cm.$^{-1}$ and a less intense band near 3,060 cm.$^{-1}$. The intensity of the latter varies widely among different compounds. It is absent in polyglycine but increases in intensity through the series polyalanine, polyvaline, polyleucine and polyisoleucine, while it is even more intense in the copolymer of D-leucine and DL-phenylalanine[3]. There is no definite maximum near 3,060 cm.$^{-1}$ in silk fibroin[3]; but in tropomyosin, myosin, fibrinogen and fibrin the absorption coefficient of this band is about one third of that of the 3,280 cm.$^{-1}$ band. In specimens of nylon the intensity is variable and may be even higher.

In two recent communications in *Nature*[3,4], important and most interesting observations have been reported on the polarization properties of these two bands in four oriented proteins and in one oriented synthetic polypeptide. On the basis of these results, a new model of the generally accepted folding of the polypeptide chain in the α-configuration of proteins has been proposed[4]. We consider that such a deduction is somewhat premature in view of a considerable amount of information which we possess on the subject of these two frequencies as a result of extensive investigations on amide spectra carried out during 1945–48 in the Department of Colloid Science, Cambridge. A full account of this work is now in preparation, but it would seem desirable to direct attention to some of the main points without more delay as they bear very directly on the important problem of protein structure, which was our ultimate objective.

Experiments in which the amides were deuterated and in which the effects of dilution in non-polar solvents were studied have shown that both these bands are most satisfactorily interpreted as NH-stretching frequencies, the hydrogen atom in each case participating in a hydrogen bond. The suggestion of Elliott, Ambrose and Temple[1] that the 3,060 cm.$^{-1}$ band is the first overtone of the 1,550 cm.$^{-1}$ (NH-deformation) frequency is highly improbable, because of the great intensity variations of the supposed overtone relative to the associated fundamental, which has much the same intensity in all the spectra cited above. Furthermore, when acetyl ethylamine is progressively diluted in carbon tetrachloride solution, the 3,280 cm.$^{-1}$ and 3,060 cm.$^{-1}$ bands disappear and are replaced by a single NH-band at 3,440 cm.$^{-1}$, which can easily be proved to arise from the stretching frequency of the NH-bond when no hydrogen bonding occurs. There is no shift of the 3,060 cm.$^{-1}$ band towards lower frequencies on dilution such as occurs in the case of the 1,550 cm.$^{-1}$ band. The 3,060 cm.$^{-1}$ band does, therefore, arise from an NH-stretching frequency which has been perturbed by hydrogen bonding, the type of bond differing from that involved in the 3,280 cm.$^{-1}$ band. It may be added that the presence or absence of water does not greatly affect these bands.

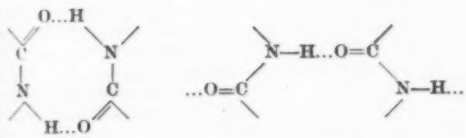
Further evidence concerning the origin of the 3,060 cm.$^{-1}$ band came from a study of the spectra

of the cyclic amides such as γ-butyrolactam and tetramethyl-diketopiperazine. Here the 3,060 cm.$^{-1}$ band is relatively more intense than in the spectra of the non-cyclic amides, while the 3,280 cm.$^{-1}$ band is absent, being replaced by a new band near 3,160 cm.$^{-1}$. These two bands also weaken on dilution in carbon tetrachloride and are replaced by a single (unbonded) NH-frequency at 3,420 cm.$^{-1}$. The two hydrogen-bonded NH-frequencies in cyclic amides necessarily arise from *cis*-configurations of the -CO.NH- group as shown in I and II. The 3,280 cm.$^{-1}$ band has not been observed in any of six cyclic amides so far studied, and it is reasonable to assume that it arises from an NH group which forms hydrogen bonds between -CO.NH- groups in the *trans*-configuration shown in III. Other investigations which would take too much space to detail here have



I

or



II III

indicated strongly that the 3,060 cm.$^{-1}$ band arises from NH bonds involved in hydrogen bonding of type II rather than type I. It may also be added that a closed ring structure such as II would be expected on general chemical grounds to have the strongest hydrogen bond, and so to show spectroscopically the greatest lowering of the NH frequency from its unbonded value.

All the above results must be taken into account in any attempt to interpret the infra-red spectra of proteins. It is essential that a clear understanding of the spectroscopic properties of the various possible hydrogen bonds which can occur between -CO.NH- groups be obtained before any sound deductions can be made regarding protein structure. We would further emphasize that there are still anomalies in the association spectra of the simple amides (not detailed here) which we have not cleared up yet, although we believe the main results quoted above can be regarded as well established.

In our previous communication[2], we stressed the fact that the presence of two NH stretching frequencies in many proteins could most naturally be explained by the existence of two types of hydrogen bonds in these proteins. We suggested that the 3,060 cm.$^{-1}$ band might be indicative of a type of hydrogen bond formed by folding of the polypeptide chain in the α-configuration, whereas the band near 3,280 cm.$^{-1}$ is most probably to be associated with inter-chain hydrogen bonding of the *trans*-configuration III. That the latter seems highly probable is strongly supported by the fact that this is the strongest band in well-oriented nylon, and has the correct polarization properties to fit in with the well-established structure from X-ray studies[5], while Ambrose, Elliott and Temple's observations[4] might be regarded as confirming the former. It seems certain now, however, that there is no definite correspondence between the occurrence of *two* types of hydrogen bonds and the α-configurations, but rather that both *cis*- and *trans*-configurations of hydrogen bonds occur in interchain, as well as intra-chain, linkages. In this connexion one of us (S. E. D.) has recently observed maxima at 3,160 cm.$^{-1}$, as well as 3,280 cm.$^{-1}$ and 3,060 cm.$^{-1}$, in proteins of the keratin–myosin–fibrinogen and collagen groups now under study.

It seems clear from the existence of two or three types of NH..OC bonds in proteins that a model for α-keratin which contains only one type of hydrogen bond, such as that proposed by Ambrose and Hanby[3], cannot but be an over-simplification of the actual state of affairs. Furthermore, it is hazardous at the present stage to try to attach significance to the numerical value of the NH dichroism of folded structures, in view of the discrepancy between the comparatively small dichroic ratios found for NH in β-keratin and nylon[4] and the large ratio to be expected.

In our opinion, much groundwork still remains to be done on the causes of the multiplicities and shifts in the NH frequencies in polyamides (including consideration of resonance and interaction phenomena) before reliable conclusions can be drawn from infra-red spectra of the proteins concerning their structure. In this connexion investigations on hydrocarbons (Stein and Sutherland, unpublished work) have shown that doubling of hydrogen frequencies may occur because of weak interactions between neighbouring chains in polythene. We hope to publish full accounts of these investigations shortly elsewhere.

We wish to acknowledge the receipt of a maintenance grant for one of us (S. E. D.) from the Medical Research Council, during the tenure of which the work on the amides was carried out.

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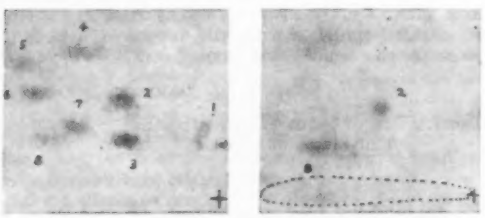
Distinctive Test for α-Amino-acids in Paper Chromatography

In the amino-acid analysis of biological fluids using paper chromatograms[1], the ninhydrin reaction indicates by means of a purple coloration not only α-amino-acids but also many other types of amino-acids and amines[2]. Spots that do not correspond in

their positions on the paper to known substances are often found in these fluids. The circumstances sometimes preclude the possibility of isolating and analysing such substances, so that we may be limited to provisional identifications based entirely on paper chromatographic procedures.

The following method is put forward as a means of distinguishing α-amino-acids and certain N-substituted α-amino-acids from most of the other substances which react with ninhydrin. It is based on the ability of compounds which have the α-amino-carboxylic structure to form copper complexes, a reaction that has been used for their quantitative assay[2,4].

The mixture to be analysed is applied to the paper in duplicate in the usual way for two-dimensional chromatography. One paper is then dusted lightly with finely powdered basic copper carbonate ($CuCO_3.Cu(OH)_2$) in the form of a streak along the path of future movement of the amino-acids in the phenol, which is used as first solvent. The dusting should leave only the slightest visible green colour, as heavier dusting appears to result in a definite weakening of the final ninhydrin colour reaction. The two chromatograms are then run in the usual way (but without additions of ammonia, sodium cyanide, ethylamine, etc.) with phenol and collidine–lutidine, and are finally treated with ninhydrin. It is convenient to use small (10–15 cm.) squares of filter paper (Whatman Nos. 1 or 4), the usual type of apparatus being prepared for them with a glass jar or accumulator tank. These squares only take 2–3 hr. to run in each solvent and are easy to handle, besides dealing satisfactorily with quantities of amino-acid of about 1 μgm. They have not the resolving power of the larger squares (18 in. × 22 in.) more usually used in paper chromatography, but as the substances surviving the copper treatment are usually few in number this is not a serious disadvantage.



Photographs of chromatograms: left, control; right, copper-dusted chromatogram

The results of such a method as applied to a synthetic mixture are shown in the accompanying reproduction of chromatograms. The control chromatogram on the left shows all the substances which react with ninhydrin, the copper-dusted one on the right shows only the substances not containing an α-amino-carboxylic acid grouping in their molecule. The latter substances have formed copper complexes which give only weak, if any, ninhydrin colours and which travel to very different parts of the paper. In these chromatograms the paper squares measured 15 cm. × 15 cm., and 5 μl. of *M*/100 amino-acid solution was applied to the cross in the right-hand bottom corner. These are larger amounts than are usually necessary. Phenol has been run from right to left followed by collidine–lutidine in an upward direction. The dotted line encloses the area dusted with copper carbonate. The identification of the spots is as follows: 1, cysteic acid (for some curious reason the R_F in collidine–lutidine is usually much smaller in the small chromatograms than on the large; it does not, therefore, appear here in its normal position in the pattern of the spots); 2, taurine; 3, glycine; 4, tyrosine; 5, leucine; 6, valine; 7, alanine; 8, γ-amino-butyric acid.

The following α-amino-acids have been shown to form copper complexes under these conditions: alanine, arginine, asparagine, aspartic acid, cysteic acid, glutamine, glutamic acid, glycine, histidine, hydroxy-proline, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophane, tyrosine, valine.

Examples of amino-acids which are not of the 'α' type and which therefore survive the copper treatment are: taurine, γ-amino-butyric acid, δ-amino-pentanoic acid, ε-amino-hexanoic acid.

The following commonly occurring amines reacting with ninhydrin have also been shown to survive: ethanolamine, ethanolamine-O-phosphoric acid, cadaverine, putresine.

Sarcosine is the only N-methyl-α-amino-acid so far studied. It readily forms a copper complex and so behaves in the test in the same way as the unsubstituted α-amino-acids. The fact that such N-substituted compounds give typical ninhydrin reactions on the paper[3] is stressed here, as it is not recorded in the earlier literature on paper chromatography. It has been claimed that they can be distinguished on the paper from the free α-amino-acids by the colour reaction with β-nitrobenzoyl chloride[5].

The behaviour of β-amino-carboxylic acids in the test, judging from the results obtained from β-alanine and β-amino-butyric acid, is likely to be ambiguous. In several runs β-alanine disappeared almost completely on the copper-dusted chromatogram, only the merest trace, if any, surviving. More β-amino-butyric acid survived. There is the possibility, therefore, of confusion with α-amino-acids. This is not likely to be a serious limitation to the method. β-Alanine is easily recognizable from its position on the chromatogram and from the bluish-purple colour it gives with ninhydrin. The longer chain β-amino-acids should be distinguishable from α-amino-acids by their instability towards mild acid hydrolysis, which would be expected to cause liberation of ammonia and the formation of an unsaturated acid. β-Amino-butyric acid, for example, is mostly decomposed within 30 min. by *N* hydrochloric acid at 100°.

By means of this method, it has been shown that the substance believed to be γ-amino-butyric acid, which has been widely found in plant and animal tissue extracts[3], does, as would be expected, appear on the copper-dusted as well as on the control chromatogram.

We wish to thank Dr. C. E. Searle for preparing for us the β-amino-butyric acid used here, and Dr. C. E. Dalgliesh for a gift of sarcosine.

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Aniline Hydrogen Phthalate as a Spraying Reagent for Chromatography of Sugars

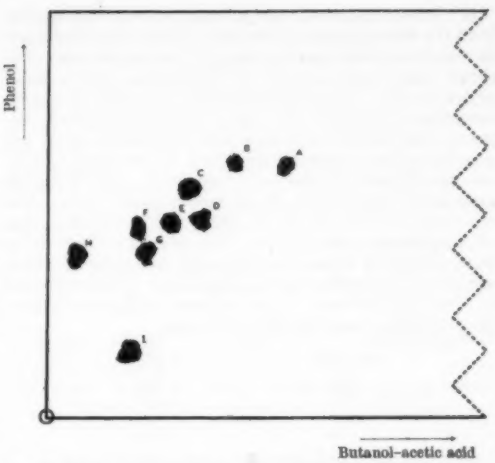
THE use of ammoniacal silver nitrate solution as a spraying reagent for revealing the presence of sugars on filter-paper chromatograms[1] has the advantage of general application; but it has a corresponding disadvantage in reacting with a very wide range of reducing substances other than the sugars, including various impurities commonly present in such solvents as phenol and collidine. Two-dimensional chromatograms are often rather unsatisfactory when ammoniacal silver nitrate is used, because (*a*) a rather large amount of the sugar mixture is needed and this increases the effect of interfering substances, (*b*) it is necessary to apply the spray as an aqueous solution, and unless the spraying is very rapid and uniform, the sugar spots migrate from wet to dry regions on the filter paper.

It has recently been found that two-dimensional chromatograms can be carried out very simply by use of aniline hydrogen phthalate as the spraying reagent. This reagent is much more selective for sugars than ammoniacal silver nitrate and is extremely sensitive for aldo-pentoses and aldo-hexoses. Furthermore, since it may be dissolved in moist butanol, migration of the sugar spots during the spraying process can be avoided. The reagent has also proved of value for use with one-dimensional chromatograms as a confirmatory test for pentoses and hexoses, and since interference from fortuitous reducing substances is largely eliminated, it often gives valuable results under otherwise unfavourable conditions.

The use of aniline hydrogen *oxalate* as a reagent for sugars was mentioned verbally during a contribution to a recent Biochemical Society discussion[2], but since the use of the acid phthalate rather than the oxalate has since proved advantageous (because of its ready solubility in organic solvents) the former is described here.

The reagent is prepared by adding aniline (0·93 gm.) and phthalic acid (1·66 gm.) to water-saturated butanol (100 ml.), and after spraying the chromatogram is heated for five minutes at 105° C. to develop the colour. The aldo-pentoses give a bright red colour, while the aldo-hexoses, desoxy-sugars and uronic acids give various shades of green and brown. With ketoses, colour development appears to depend upon the solvent used for developing the chromatograms, and on chromatograms irrigated with phenol or butanol-acetic acid mixture the reaction with fructose was either absent or very weak. Under these conditions, no colour was observed with raffinose, and reactions of intermediate strength were given by various disaccharides and amino-sugars. The reagent is very sensitive for both pentoses and aldo-hexoses, and will detect as little as 1 μgm. of either.

The accompanying photograph shows a two-dimensional chromatogram carried out with a mixture of nine common sugars using aniline hydrogen phthalate as the spraying reagent. It was prepared following generally the directions given by Consden, Gordon and Martin[3] for amino-acids. About 3 μl. of the mixed sugar solution (approximately 1 per cent with respect to each sugar) was applied to a standard sheet of Whatman No. 1 filter paper at the point marked by a circle. The chromatogram was irrigated first with phenol in the short direction of the paper (24 hr.), and was then turned through 90° and



Key: *A*, Rhamnose; *B*, ribose; *C*, arabinose; *D*, xylose; *E*, mannose; *F*, galactose; *G*, glucose; *H*, lactose; *I*, galacturonic acid

irrigated with butanol-acetic acid mixture[1] (24 hr.), the solvent being allowed to drip off the paper when the boundary reached the bottom edge. (In order to allow the solvent to drip uniformly the bottom edge of the paper was cut into a series of points at uniform intervals.) The reproduction was made by taking a reflex photograph of the chromatogram using Ilford Document Paper No. 50.

I wish to acknowledge the assistance of Mr. D. F. Elsden.

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Inorganic Paper Chromatography: the Qualitative Separation of Aluminium and Beryllium

R. P. LINSTEAD *et al.*[1] have described the separation by means of paper chromatography of aluminium, gallium, indium and zinc from solutions of their chlorides in *n*-butyl alcohol containing hydrochloric acid as a solvent. According to their work, aluminium scarcely moves at all from the original position, while the other elements move varying distances down the paper. We have recently followed their technique in an attempt to separate aluminium and beryllium, but instead of developing the aluminium with 'Aluminon', we have incorporated the technique of development by fluorescence first proposed by Pollard *et al.*[2]. After separation on the paper, the positions of the aluminium and beryllium spots are shown by spraying with an alcoholic solution of 8-hydroxyquinoline. Both the aluminium and the beryllium then fluoresce under ultra-violet light and can, indeed, be observed in strong sunlight. The fluorescence is intensified on drying the paper and exposing to ammoniacal vapours.

We have confirmed that aluminium scarcely moves from its starting point, but have found that beryllium moves down the paper giving a clear separation. For these experiments strips of Whatman No. 1 filter paper about 1 in. wide were used, and, using the well-described technique of paper chromatography[2], the spots were eluted with a solvent consisting of 80 per cent by volume of *n*-butanol and 20 per cent of concentrated hydrochloric acid (AnalaR). After elution overnight, the solvent front moves about 8 in. The R_F value of aluminium is about 0·03, whereas that of beryllium is about 0·3. Satisfactory separations were achieved when the following amounts of aluminium and beryllium as a solution of their chlorides in 0·01 ml. of dilute hydrochloric acid were placed on the paper and eluted overnight.

Aluminium	Beryllium
10 γ	20 γ
110 γ	8 γ
11 γ	170 γ
300 γ	2 γ
2 γ	300 γ

This technique provides a valuable method of detecting traces of aluminium in beryllium salts of reagent-grade quality, and also of traces of beryllium in the presence of aluminium. Its application to quantitative estimations should prove useful and work is proceeding along these lines.

During these experiments, a dark band across the width of the paper and about ½ in. deep was obtained at the solvent front. This is probably due to impurities in the paper.

It is worth noting that on occasions using other solvents, we have found impurities carried down the paper which often concentrate at the solvent front. For example, using *N*/100 hydrochloric acid as solvent, a band is obtained at the solvent front which gives a very intense fluorescence with 8-hydroxyquinoline. If this band is cut off and the paper washed and used again in the same way, no concentration of impurities at the solvent front is observed.

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Paper Partition Chromatography of Reducing Sugars with Benzidine as a Spraying Reagent

In the course of investigations into the application of paper chromatography to the identification of reducing substances in urine it was found that, when ammoniacal silver nitrate was used as a developing reagent, urates, normally present in urine, produced a dark brown spot with an R_F value of approximately 0·20. This spot, which generally 'tails', tends to mask the spots produced by other reducing substances with R_F values in the region of 0·20, namely, those of glucose, sorbose, arabinose and fructose.

Demineralization of the urine by means of ion-exchange resins[1], in an attempt to remove the urates, proved unsuccessful. A benzidine reagent has been formulated, however, which, although reacting with reducing sugars, does not react with urates. The reagent is prepared as follows: benzidine AR, 0·5 gm.; glacial acetic acid, 20 ml.; absolute ethanol, 80 ml. The chromatogram, after drying to remove the solvent, is sprayed with this reagent and then heated in an oven at 100°-105° C. for fifteen minutes, observing at five-minute intervals.

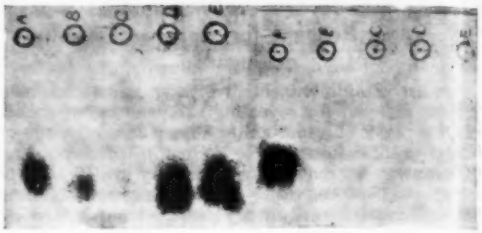

Fig. 1 Fig. 2

Pentoses produce a characteristic chocolate brown spot within five minutes. Lactose, maltose, galactose, glucose and lævulose form dark brown spots within ten minutes. Ascorbic acid gives a faint brown spot after ten minutes. Urates, in concentration much greater than that normally found in urine, may produce a very faint spot; but even then the colour is not sufficient to interfere with the spots produced by reducing sugars. The reagent will detect 5 μgm. of all the reducing sugars. In particular, it is a more sensitive reagent for lactose and maltose than ammoniacal silver nitrate. Unlike ammoniacal silver nitrate, the benzidine reagent is only slightly affected by light and heat. Even after exposure to daylight for a few days the filter paper background is only coloured a pale brown, in contrast to the dark brown spots produced by reducing sugars.

There is normally no reaction with urines containing pus or blood, but specimens which are grossly contaminated with blood occasionally produce a faint violet-coloured spot with an R_F value of approximately 0·28.

Fig. 1 shows a series of five urine samples. Specimens *A* and *D* were suspected of containing traces of reducing substances by Benedict's qualitative test. Specimens *B*, *C* and *E* are normal urines giving a negative reaction with Benedict's test. The chromatogram was run for 24 hours using *n*-butanol-acetic acid-water[1] as the solvent mixture. The chromatogram was then sprayed with ammoniacal silver nitrate reagent.

Fig. 2 indicates the same urine samples, chromatographed under similar conditions to Fig. 1, but sprayed with the benzidine reagent. In this case only one spot has developed, and urine *A* is the only specimen containing a reducing sugar (which was identified as glucose). The other spots given with ammoniacal silver nitrate (Fig. 1), from urine samples *B*, *C*, *D* and *E*, are due to urates. Urine *D* contained a large quantity of urates, which probably accounts for the doubtful reaction with Benedict's reagent.

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A Peptide-like Contaminant of Filter Paper

THE 'cutting-out' technique described by Consden, Gordon and Martin[1], and Dent[2], for isolating a ninhydrin reacting substance, was applied to the study of these substances in urine. Twelve 20 μl. drops of urine were run side by side on Whatman No. 1 filter paper with phenol–ammonia–hydrogen cyanide. After developing the outer runs with ninhydrin, transverse strips were cut isolating the ninhydrin positive and negative areas. Chromatography of the hydrolysed eluate of each strip (including the negative ones) revealed a number of amino-acids in addition to those originally present in the urine.

Two possible explanations were: (1) The additional amino-acids were derived from a contaminant in the filter paper; (2) urine contains peptides not reacting with ninhydrin.

Evidence for the presence of a peptide-like contaminant in filter paper as supplied, is as follows:

Whatman Nos. 1, 2 and 4 filter papers, size 18–22 in., were examined. Each paper was set up as for a chromatogram using distilled water as the solvent. The water was allowed to run off for five days into a receiving trough. Each 24-hour collection was filtered, and then evaporated to dryness. The first two 24-hour samples contained appreciable amounts of solid, partly crystalline material, the subsequent three, negligible amounts. Test chromatograms of each residue gave no spots reacting with ninhydrin. The material from days 1 and 2 was pooled, the resulting four specimens were hydrolysed (6 *N* HCl, 105° C., 24 hours), and subjected to two-dimensional chromatography. The 48-hour specimen showed many ninhydrin reacting substances as well as substances, evidently inorganic salts and carbohydrates, which caused considerable distortion of the chromatogram. However, it was possible to identify aspartic cysteic and glutamic acids, glycine and proline, and probably alanine, valine, leucine, arginine and tyrosine. The 3rd-, 4th- and 5th-day specimens gave no ninhydrin-reacting substances, from which it was concluded that the results were not artefacts due to the procedures used, and that the peptide-like contaminant could be removed from the paper by working for forty-eight hours with distilled water. It is of interest that this substance does not move so rapidly as the water front, thus differing from amino-acids and simpler peptides.

Strips one inch wide of the whole length of the paper yielded a hydrolysate with sufficient amino-acids to be detected as discrete spots. The yield of contaminating material was not increased by using *N*/2 hydrochloric acid as the solvent.

These observations may throw further light on the nature of the contaminating acidic and basic substances recently found in filter paper by Martin and Mittelman[3]. They indicate that prior to the isolation of substances by 'cutting-out' procedures, the filter paper should be examined for impurities or washed in the manner outlined. Washed filter paper has certain other advantages. Interfering background colours, and distortion of the lower part of the two-dimensional chromatogram of urine (phenol–ammonia–hydrogen cyanide first solvent, 'Collidine' second), found consistently with unwashed paper is much reduced using washed paper. Similarly, interfering background effects are significantly reduced in sugar chromatography by the Partridge method. Whatman No. 1 paper is 25 per cent 'faster' after washing, the speed of No. 4 is unchanged.

That urine may contain peptides not reacting with ninhydrin was confirmed by repeating the original observations using washed filter paper. The presence of such peptides in urine makes it difficult to establish by hydrolysis and subsequent chromatography, the homogeneity of a ninhydrin-reacting substance isolated from urine by the cutting-out method.

The details of these experiments will be reported separately.

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Thermodynamic Conditions for the Retention of Solvents by Crystals: the System Brucine/Benzene

IN work involving the preparation of pure optically active compounds for physico-chemical studies, it has been found that brucine crystallizes from benzene solutions with one molecule of benzene per molecule of brucine.

The benzene of crystallization is held by brucine molecules with remarkable tenacity. At room temperatures no measurable loss of solvent occurs on grinding, or on exposing the crystals to a vacuum of 10^{-4} mm. mercury for several hours. In fact, the benzene does not come off until at about 125° C. in a vacuum of 10^{-4} mm. and at about 140° C. at ordinary pressures. When this removal does take place, evolution of benzene vapour can be almost explosive.

Tests show that brucine does not retain any solvent molecules when recrystallized from toluene, *p*-xylene or mesitylene. It is only slightly soluble in cyclohexane. This contrast with benzene suggests that the size of the molecule is important, in addition to the polarizability and other factors, in determining the remarkable tenacity of retention in the crystal. It was previously known that brucine crystallizes with four molecules of water from aqueous alcohol, and it has now been found to crystallize with one molecule of ethyl alcohol from 99·9 per cent alcohol. However, these two solvents are removed fairly readily at about 100° C.

Benzene of crystallization has been reported in a number of cases, usually in the 1 : 1 proportion. In addition to forming crystal compounds with aromatic polynitro-derivatives, benzene forms crystal complexes with such molecules as: $(C_{10}H_7)_3CH(OH)$, $C_6H_5.N : N.C_6H_5$, $C_6H_5.CH(SCN)CH_2SCN$ (ref. 1).

The molecules 5-phenylacridine (ref. 2) and quinine (ref. 3) are of interest in that their structures have certain analogies with that of brucine, and form 1 : 1 complexes with benzene.

So far as the literature records are available, it appears that benzene is fairly readily removed from most of these molecular complexes. Tenacious retention of benzene has been reported in the case of molecules such as: $(C_{10}H_7)_3(COO)_2$ (ref. 4) and $S(CH_2.p\text{-}C_6H_4.NH.CO.NH_2)_2$ (ref. 5).

The structure of brucine, so far as it is known, does not indicate any groups which would have exception-

ally powerful attraction for benzene. When the thermodynamic implications of the tenacious retention of benzene by brucine in the crystals are considered, it may be significant that pure molten brucine normally solidifies to a glass, and only crystallizes with difficulty. Two alternative mechanisms for the removal of benzene can, therefore, be considered.

	Brucine/benzene (complex)	→	brucine (supercooled melt)	+ benzene (vapour, p_1)	+ ΔG_1	(1)
Free energies/mol.	G_c		G_m	G_1		

	Brucine/benzene (complex)	→	brucine (crystal)	+ benzene (vapour, p_2)	+ ΔG_2	(2)
Free energies/mol.	G_c		G_c	G_2		

Below the freezing point of brucine (451° K.), the first process leads to a smaller decrease of free energy than the second,

$$\Delta G_1 - \Delta G_2 > 0. \quad (3)$$

It is possible to estimate a lower limit for the ratio p_2/p_1, as follows :

	Brucine (crystal)	→	brucine (melt)	+ ΔG_2.	(4)
Free energies/mol.	G_c		G_m		

At a temperature t ° K. below the freezing point f ° K., the following relations hold (where H and C have conventional meanings) :

$$\Delta H_t = (H_m - H_c)_t = \Delta H_f + \int_f^t \frac{d\Delta H}{dT}\, dT =$$

$$\Delta H_f + \int_f^t \frac{d\Delta H}{dT}\, dT = \Delta H_f + \Delta C(t-f). \quad (5)$$

Similarly :

$$\Delta S_t = (S_m - S_c)_t = S_{m_f} + \int_f^t \frac{C_m}{T}\, dT -$$

$$\left[S_{c_f} + \int_f^t \frac{C_c}{T}\, dT\right] = \Delta S_f + \int_f^t \frac{C_m - C_c}{T}\, dT =$$

$$\Delta S_f + \Delta C \ln t/f, \quad (6)$$

if it is assumed that there is a constant difference ΔC between the specific heat of the supercooled melt C_m and crystals C_c (cf. ref. 7).

Since $\Delta G_{2t} = \Delta H_t - t\Delta S_t$.

From (5) and (6) $\Delta G_{2t} = \Delta H_f + \Delta C(t-f) - t\Delta S_f - t\Delta C \ln t/f$

But $\Delta H_f = f\Delta S_f$.

$$\therefore \Delta G_{2t} = \Delta S_f (f-t) + \Delta C\,[t(1 - \ln t/f) - f]. \quad (7)$$

ΔG_2 can also be related to ΔG_1 and ΔG_2 by subtracting (1) from (2)

$$\Delta G_1 - \Delta G_2 = (G_m - G_c) + (G_1 - G_2). \quad (8)$$

From (4), neglecting the variation of G_m and G_c with pressure, we have :

$$\Delta G_{2t} = G_m - G_c$$
$$\Delta G_1 - \Delta G_2 = \Delta G_{2t} + (G_1 - G_2).$$

Using the inequality (3),

$$(G_1 - G_2) + \Delta G_{2t} > 0,$$

and inserting the expression for the molar free energies of benzene vapour, we get

$$Rt \ln p_1/p_2 > -\Delta S_f (f-t) - \Delta C[t(1-\ln t/f) - f].$$

Inserting numerical values in the above expression, ($t = 298°$ K., $f = 451°$ K., ΔS_f may be 50 or more by analogy with other large molecules), this gives very small values of p_1 even if p_2 is appreciable. As soon as the temperature and other conditions favour the crystallization of the brucine in the act of evolution of benzene, the partial pressure will be controlled by equation (2) instead of equation (1), which immediately gives a much higher partial pressure. On this view, a contributory factor in the tenacious retention of benzene is the high entropy of fusion, and difficult crystallization of the molecules in the act of removing the benzene.

This thermodynamic explanation of high retaining power of certain crystals for solvent molecules does not necessarily exclude the considerations about molecular size advanced by other authors (for example, 'clathrates'[6]), as well as considerations of polarity, and polarizability, all of which determine the conditions for packing solvent molecules in crystal lattices.

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The Bromine Cation, Br^+, and its Reactions

SIR CYRIL HINSHELWOOD has recently[1] revived the old Noyes—Lowry suggestion that bromine may sometimes react in water after complete dissociation, $Br_2 \rightleftharpoons Br^- + Br^+$, and not merely as an inductively polarized molecule, while Weiss[2] has tentatively suggested that the simple bromine cation may exist in acid solutions of hypobromous acid : $HOBr + H^+ \rightleftharpoons Br^+ + H_2O$. Direct experimental support for the latter suggestion has not as yet been put forward.

We have recently had occasion to prepare bromide-free solutions of hypobromous acid, and were surprised to find that they appeared to be very much more reactive than free bromine in mineral acid, though not in approximately neutral, solutions. For example, (i) immediate addition to maleic acid occurred in the dark ; (ii) an immediate separation of bromobenzene was observed when hypobromous acid was added to an acidified (sulphuric acid) but not to a neutral solution of benzene in water (c. $M/100$) ; (iii) even benzoic acid was converted to *m.* bromobenzoic acid in fairly strong nitric or sulphuric acids. Neither benzene nor benzoic acid was attacked by free bromine in aqueous mineral acids of comparable strength.

This degree of reactivity accords with the view that the bromine cation, Br^+, is the active entity concerned, perhaps as such, though more probably in the hydrated form of $(H_2OBr)^+$, derived from the equili-

brium $HOBr + H^+ \rightleftharpoons (H_2OBr)^+$, in which the completeness of electron octets is preserved.

Since free hypobromous acid is best prepared by distilling a mixture of bromine-water and silver sulphate, it logically followed that an active brominating agent should be obtained by treating acidified bromine-water with a salt of silver, lead or other cation capable of removing bromide anions from solution. Our tests have shown that this is indeed the case. Benzene can be brominated in high yield (at least 80 per cent calculated on Br_2) by stirring with bromine in a large volume of cold $2N$ nitric acid and then dropping in slowly an equivalent of silver nitrate solution. Lead nitrate acts similarly but less efficiently on account of the greater solubility of lead bromide; but with this latter mixture toluene is very easily brominated in the nucleus.

Since acetic acid appears to be inert to the bromine cation Br^+, this novel reaction is capable of wide extension to substances which are only sparingly soluble in water. From preliminary experiments, the speed of bromination appears to be dependent upon the strength of the mineral acid employed.

We propose to study more extensively both the scope and the kinetics of this reaction.

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Organo-Cobalt Compounds

We have attempted to prepare organo-cobalt compounds by various methods, including thermal decomposition of cobalt *p*-toluenesulphinate, thermal and copper catalysed decomposition of addition compounds of cobalt chloride and diazonium chlorides and of phenyldiazonium cobaltinitrite[1], and refluxing diphenyliodonium iodide with finely divided cobalt powder in *n*-propanol[2]. All these experiments were unsuccessful, although in some cases traces of benzene-soluble organic materials with varying cobalt contents were obtained.

Organo-cobalt compounds were obtained by the following technique. $RMgX$ (R = 1-naphthyl or 2-naphthyl, X = Br or I) in ether was added to ethereal solutions of cobalt bromide or cobalt iodide at room temperature. The dark precipitate was extracted with benzene at room temperature. The green benzene solution was treated with five volumes of low-boiling petrol ether. The precipitates were filtered, analysed and found to correspond to the formulæ $RCoI_2$ and R_2CoBr_2. Precipitation from benzene solution with dioxane yielded compounds of the formulæ R_2CoI_2 and R_2CoBr_2. Compounds of the type R_2CoX_2 were somewhat less pure than the products obtained by precipitation with petrol ether.

It was found that dioxane slowly decomposes all organo-cobalt compounds prepared by us. The organo-metallic nature of the products was established by their decomposition in water, which afforded the expected dinaphthyls[3] in addition to cobalt hydroxide, cobalt iodide and varying amounts of free iodine. The residue which was left behind after the extraction with benzene did not contain cobalt metal.

With the exception of 1-$RCoI_2$, which gave fairly pure 1,1′-dinaphthyl, the dinaphthyl preparations from the aqueous decomposition of the organo-cobalt compounds were impure owing to contamination with naphthalene and possibly polynaphthyls.

Naphthylmagnesium bromides and cobalt iodide gave $RCoI_2$, and the same products were obtained from reactions between naphthylmagnesium iodides and cobalt bromide. The iodine derivatives were obtained in better yields than the corresponding bromine derivatives. The average yields were better in the 1-naphthyl series (60 per cent for $RCoI_2$ and 20 per cent for $R_2Co_2Br_2$) than in the 2-naphthyl series (47 per cent for $RCoI_2$ and 9 per cent for $R_2Co_2Br_2$). The yields of the compounds R_2CoX_2 were considerably lower, particularly for the compounds R_2CoBr_2, which are appreciably soluble in dioxane. Both $RCoI_2$ compounds are green and decompose around 160°. Both R_2CoI_2 compounds are reddish-brown; the 1-compound decomposes at about 150–160° and the 2-compound at about 90°. The bromine compounds are blue. The approximate temperatures of decomposition are: 1-$R_2Co_2Br_2$, 120°; 2-$R_2Co_2Br_2$, 150°; 1-R_2CoBr_2, 120°; and 2-R_2CoBr_2, 65°.

The bromine derivatives are less soluble in chloroform or in ether than the corresponding iodine compounds. The solubility in benzene of all the compounds examined is very slight. This indicates that the original benzene extract does not contain the organo-cobalt compounds in the forms in which they have been identified. Lack of equipment has prevented us from carrying out magnetic measurements; but offers have been received from other institutes to supply these vital data. Unfortunately, the preparations are unstable and difficulties arising out of this fact have not been overcome.

Attempts have been made to prepare similar organo-cobalt compounds with methyl, ethyl, propyl, *iso*propyl and phenyl radicals by similar techniques. Compounds of the type $RCoI_2.2C_6H_6$ were obtained with the aliphatic radicals, and an equimolecular addition compound of $EtCoI_2$ and 1-chloronaphthalene was also obtained. Phenylmagnesium bromide and cobalt bromide afforded $PhCoBr_2.C_6H_6$ and $Ph_2CoBr_2.C_6C_6$. These experiments, however, will require further confirmation.

We wish to thank the Electrolytic Zinc Company of Australasia, Ltd., for a generous grant.

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Water-Insoluble Complexes of Simple Aryl Sulphonates and Gelatin

The combination of organic anions such as alkyl sulphates, acid dyes, and commercial detergents with proteins has been the subject of considerable published work[1–7]. When alkyl sulphates (not less than ten carbon atoms in the paraffin chain), such detergents as 'Teepol' (secondary alkyl sulphate) or alkyl–aryl sulphonates combine with gelatin, complexes may

be formed which are insoluble in water or aqueous electrolytes. As the ratio of anion to gelatin is increased from zero, complexes of decreasing water-solubility are formed until a certain proportion is reached (value depending upon *p*H, electrolyte, concentration of electrolyte, etc.), corresponding with the complex of minimum water-solubility. Such a complex is found also to have maximum solubility in organic solvents[1,4]. Further increase in anion to gelatin ratio beyond this value causes peptization.

It has now been found that simple aryl sulphonates (not alkyl-substituted) similarly form water-insoluble complexes with gelatin, but with certain important differences. Maximum combining proportions of aryl sulphonate with protein give a complex of minimum water-solubility and maximum organic-solvent solubility; but beyond this value there is no evidence of peptization. This presumably is due to the incapacity of the molecules to form sufficiently numerous van der Waals' linkages to give a reversibly adsorbed layer, such as is postulated to be responsible for peptization with paraffin chain salts[1].

It is of interest to compare this difference in behaviour with the fact that, whereas alkyl sulphates and alkyl-substituted aryl sulphonates readily form micelles in aqueous solutions, unsubstituted aryl sulphonates do not appear to do so to anything like the same degree. This is another indication of a smaller tendency to form van der Waals' intermolecular bonds.

The formation of insoluble complexes by protein–anion interaction is attributed to ionic combination of the anion with cationic protein groups, giving an increasingly hydrophobic compound up to the point of maximum separation. Reverse adsorption (van der Waals' forces) of a further molecule, with anionic head-group orientated away from the protein group, accounts for the increasing hydrophilic character beyond this maximum value (that is, peptization).

The ionic nature of the linkage between protein (gelatin) and aryl sulphonates (for example, naphthalene sulphonates) is further confirmed by the observation that maximum combining ratios of naphthalene 2 monosulphonate, naphthalene 1 : 3 disulphonate and naphthalene 1 : 3 : 5 trisulphonate, with gelatin approximate to 3 : 2 : 1 in terms of mgm. mol. per gm. of protein.

Further details of this work will be published later.

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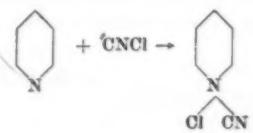
New Test for Free Chlorine or Bromine

There has been, to date, no reagent available for detecting and measuring the minute traces of free chlorine such as occur in drinking water, etc., after sterilization. It should be emphasized that the usual methods employed do not measure free chlorine, but rather indicate oxidative potential, and results so given are, therefore, subject to considerable errors should oxidizing agents other than chlorine be present in the solution. Thus the popular *ortho*-tolidine technique[1] is considerably affected if iron and similar metallic salts are present, and also gives a modified colour if the oxidation potential is diminished, as occurs when ammonia salts are present. Similarly, the benzidine blue[2] and iodide replacement methods[3] are likewise affected. Because of these complications, Palin[4] introduced a modification of the *p*-amino-dimethylaniline test, with which it was claimed a more specific result was possible. But this reagent is still an oxidation indicator, and therefore on occasion the test must be effected by substances other than chlorine.

A test is now put forward which is specific for free chlorine (only free bromine reacting similarly). It is based on the fact that free chlorine reacts directly with cyanides to form cyanogen chloride, thus :

$$NaCN + Cl_2 \rightarrow NaCl + CNCl.$$

Cyanogen chloride is now allowed to react with pyridine (or a pyridine derivative) to form a quaternary compound :



which on subsequent condensation with aromatic amines produces a ring fissure and the formation of intensely coloured di-anil derivatives.

To carry on the test, two reagents are made as follows : (*a*) Sodium cyanide solution 1 per cent and (*b*) pyridine 25 per cent containing 2 per cent of benzidine hydrochloride. 5 ml. of water is treated with 1 ml. of cyanide solution, to which is then added 5 ml. of the pyridine reagent. The reddish colour which is fully developed within ten minutes may be compared visually against standards or measured in a photo-electric instrument.

The test is approximately twice as sensitive as with the tolidine reagent, and, as stated above, is specific, except in the presence of free bromine.

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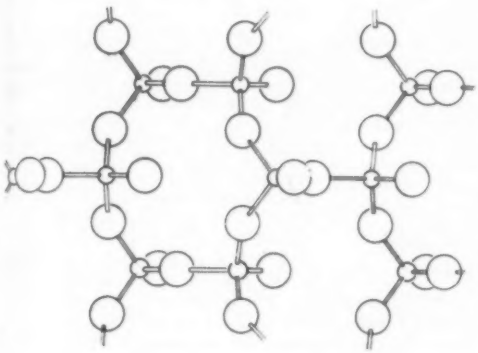
Crystal Structure of the Third Form of Phosphorus Pentoxide

The structure of two forms of phosphorus pentoxide was determined several years ago[1,2]. Indications of the existence of a third form has been found in a study of the phase diagram by Hoeflake and Scheffer[3]. Actually, in our former investigations we found occasionally a third kind of crystals, and we determined their cell dimensions and space group[4]. However, we were not sure that these crystals were pure phosphorus pentoxide and not a reaction product with the glass wall, to which they adhere extremely

firmly. Hill, Faust and Hendricks[5] put the existence of a third form beyond doubt. They considered the modification as probably tetragonal (instead of orthorhombic, as found by us), as a result of optical investigation. According to their powder diagram data, however, it is certain that their crystals are identical with those described by us[4].



After the War, the paper of Hill *et al.* came to our knowledge; we resumed the X-ray investigation of the third form of phosphorus pentoxide and have now completely determined its crystal structure.

Space group $Pnam-D_{2h}^{16}$. $a = 9{\cdot}23$ A.; $b = 7{\cdot}18$ A.; $c = 4{\cdot}94$ A.

Four molecules P_2O_5 per cell.

P_I	in (4c) with	$x =$	$0{\cdot}244$,	$y =$	$0{\cdot}288$
P_{II}	,, ,, ,,	$x =$	$-0{\cdot}098$,	$y =$	$-0{\cdot}156$
O_I	,, ,, ,,	$x =$	$-0{\cdot}219$,	$y =$	$-0{\cdot}011$
O_{II}	,, ,, ,,	$x =$	$-0{\cdot}142$,	$y =$	$0{\cdot}346$
O_{III}	,, ,, ,,	$x =$	$0{\cdot}055$,	$y =$	$-0{\cdot}089$
O_{IV}	,, (8*d*) ,,	$x =$	$0{\cdot}136$,	$y =$	$0{\cdot}282$, $z = 0{\cdot}000$

The structure consists of corrugated sheets, parallel to (100). One such sheet is shown in the accompanying diagram, projected along the *a*-axis. Two sheets run through the unit cell. The linking in the sheets is of the same general type as in vanadium pentoxide[6]. In details, the two structures differ considerably: the tetrahedra in phosphorus pentoxide are much less deformed than those in vanadium pentoxide, the binding in the sheet is more isotropic and the packing is more dense.

A full account of the structure analysis will be given elsewhere.

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Structure of Aluminium Soaps

In the course of a study of the water sorption of aluminium soaps, Shreve, Pomeroy and Mysels[1] found that pure aluminium laurate which had been dried *in vacuo* over phosphorus pentoxide at room temperature gave $2{\cdot}5 \pm 0{\cdot}4$ per cent of water when examined with the Karl Fischer reagent. They maintained, consequently, that the reagent gives misleading results because, under the conditions of the determination, soap molecules react with each other, or with free acid, to give water, thus:

$$2AlR_2OH \rightarrow R_2Al - O - AlR_2 + H_2O \quad (1)$$
$$AlR_2OH + HR \rightarrow AlR_3 + H_2O. \quad (2)$$

It occurred to us, however, that a simpler explanation would be that the water found by the Karl Fischer reagent exists as such in the authors' "dry" soap, but adsorbed on the molecule. Alternatively, it has been suggested by Schulman and McRoberts[2] that in aluminium soaps the aluminium atom acts as a hexavalent co-ordination centre for water, hydroxyl groups, fatty acid, etc.[3], and it is well known[4] that under the conditions of the Karl Fischer reagent, methyl alcohol can replace water molecules in a complex compound.

An opportunity to decide between these theories is presented by the reaction between aluminium alcoholate and a fatty acid. We prepared a solution of pure, redistilled aluminium *sec*-butylate in dry *sec*-butyl alcohol and added two equivalents of a pure vacuum-distilled synthetic long-chain fatty acid, thus:

$$Al(OBu)_3 + 2HR \rightarrow AlR_2OBu + 2BuOH. \quad (3)$$

The calculated quantity of water, dissolved in *sec*-butyl alcohol, was then added as follows:

$$AlR_2OBu + H_2O \rightarrow AlR_2OH + BuOH. \quad (4)$$

At this stage, there is thus no free water present as adsorbed molecules. Titration of this solution with the Karl Fischer reagent, however, resulted in the quantitative recovery of water according to equation (1) above, thus supporting the contention of the American workers.

This application of the Karl Fischer reagent as an analytical tool in the assessment of structure possesses interesting possibilities, and it is proposed to pursue this aspect further. Full details of the work will be published elsewhere.

We wish to thank the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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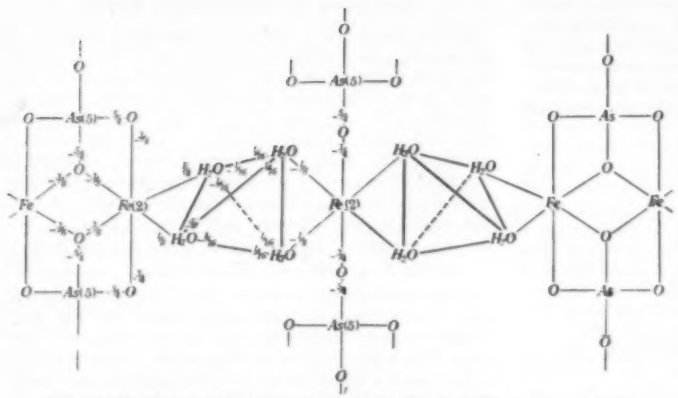
Structure of Vivianite and Symplesite

The role of water in the structure of crystals is so manifold that a great deal of experimental data must be accumulated before we can safely judge its significance. The following is another example for consideration.

C. W. Wolfe[1] ascribed the triclinic space group $C_i^1 - P\bar{1}$ to symplesite; but we have found it has the



Electrostatic balance around the tetrahedron formed of H_2O in symplesite, $Fe_3(AsO_4)_2.8H_2O$

same space group $C_{2h}^3 - C\,2/m$ as vivianite and other minerals of the group. The structure of vivianite, $Fe_3(PO_4)_2.8H_2O$, and symplesite, $Fe_3(AsO_4)_2.8H_2O$, as worked out lately by H. Mori and myself using X-rays, has revealed that it is built up of octahedral groups of oxygen atoms and water molecules around the atoms of iron. Of these octahedral groups, two identical ones are grouped together holding an O—O edge in common. Such a double octahedral group, $Fe_2O_6(H_2O)_4$, is linked to two neighbouring similar groups and to four other single octahedral groups, $FeO_2(H_2O)_4$, by phosphorus (or arsenic) atoms which lie in the middle of a tetrahedron formed of four oxygen atoms. This linking repeats indefinitely throughout the structure, making up a complex sheet stretched parallel to (010).

Water molecules are on both sides of such sheets and join them together by weak bonds caused by their tetrahedral arrangement. Since two constituent water molecules of the tetrahedron each form a part of the single octahedral group, $FeO_2(H_2O)_4$, on one hand, and the remaining two each a part of the double group, $Fe_2O_6(H_2O)_4$, on the other, the balance of valency is such that the first two water molecules are to match each the residual bond of $+\ 1/8$ and the latter each that of $-\ 1/8$, making them equally but oppositely polarized (see diagram). The tetrahedral arrangement of water molecules, which, it is said[2], have themselves a tetrahedral configuration of charges, appears to be well stabilized in the structure of these minerals.

Details of the structure of vivianite and symplesite will be published elsewhere shortly.

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Viscosity of Polyvinyl Chloride Solutions

It is well known that one of the 'best' solvents for polyvinyl chloride is cyclohexanone; it can dissolve more polymer than, for example, methyl ethyl ketone before visible signs of gelling appear. According to Frith[1], therefore, it would be expected that whereas plottings of η_{sp}/c against c for dilute solutions of polyvinyl chloride in these two solvents would show roughly identical intercepts, $[\eta]$, at $c = 0$, the slope of the curve would be greater in the case of the cyclohexanone solution. We have found the reverse to be the case (Table 1).

It was of interest to study the variation in slope as the solvent cyclohexanone was gradually replaced by methyl ethyl ketone and *vice versa*. This experiment was carried out by preparing a solution of polyvinyl chloride ('Corvic', standard grade supplied by I.C.I., Ltd.) in cyclohexanone (0·8 gm./100 ml.); after the viscosity had been measured, the solution was diluted with a known proportion of methyl ethyl ketone, the viscosity again measured, and so on. The points of η_{sp}/c against c thus obtained were joined to their appropriate intercepts, these being determined by assuming a linear relation between intercept and solvent composition. In this manner 'corrected slopes' were obtained as a function of solvent composition, both for a cyclohexanone solution diluted with methyl ethyl ketone, and conversely. These relations are shown in the accompanying graph.

Table 1

Solvent	$[\eta]$	$\frac{d(\eta_{sp}/c)}{dc}$	No. of points	Standard deviation
Cyclohexanone	6·25	19	8	0·2
Methyl ethyl ketone	5·6	32	6	Very low

This shows, first, that our assumption of a linear relation between intercept and concentration is incorrect, for negative slopes are absurd. Secondly, the widely differing slopes of the two solutions in, say, equal parts of cyclohexanone and methyl ethyl ketone indicate that the viscosity curve is sensitive to the order of addition of solvents to the polymer; this conclusion was confirmed by a test experiment, adding the solvents in different orders, and also dissolving the polymer directly in the mixed solvents (Table 2).

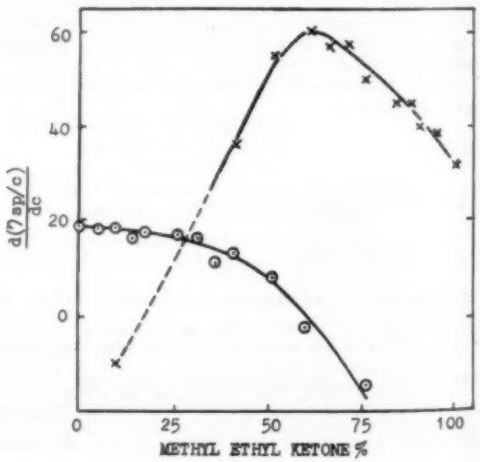

Table 2

Solvents		η_{sp}/c	
First	Second	Immediate	After 4 weeks
Cyclohexanone	Methyl ethyl ketone	7·8	8·0
Methyl ethyl ketone	Cyclohexanone	10·7	7·9
Mixed solvents		7·5	7·8

These results suggest that: (1) Different solvents solvate the polymer to different extents, thus affecting the viscosity of the solution. (2) Cyclohexanone is bound to the polymer in preference to methyl ethyl ketone. (3) When the polymer, solvated with methyl ethyl ketone, is brought into contact with cyclohexanone, the preference for cyclohexanone is not shown immediately, but the solvent exchange takes place slowly. Hence solvent molecules are firmly bound, and not entrapped in the coils of the chain.

We express our thanks for the practical assistance of Miss C. Mayson, and to the "Shell" Refining and Marketing Co., Ltd., for permission to publish this communication.

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Electrophotography of Internal Discharges in Dielectrics

Electrophotographs of discharges in air inclusions in dielectrics have been used for demonstrating the location and sequence of discharges during the short-time application of alternating and direct voltages[1]. A photographic film was enclosed between two disks of dielectric carrying silver film electrodes, one disk having a small cylindrical cavity adjacent to the photosensitive surface (Fig. 1). The sample was tested in conjunction with a discharge recorder[2]. Alternating voltage was applied for 1/25–1/10 sec.

The enlarged photographs in Fig. 2 show discharges in a cavity 0·5 cm. in diameter, and 0·03 cm. in thickness between polythene disks, for different conditions of applied voltage. The superimposed white circles define the circumference of the cavity.

The discharge sites recorded in the electrophotographs are fewer than the discharges in the corresponding oscillograph records, so that at some sites discharges must have recurred in successive voltage cycles. In the original, about twelve large diameter discharge sites and a similar number of smaller sites are visible in Fig. 2*a*. It is probable that the small areas represent single discharges, whereas the larger areas represent several successive discharges.

The sites occur in clusters, and the formations shown in Figs. 2*a* and *b* support a modified hypothesis of the discharge sequence in dielectrics, in which account is taken of the annular distribution of charge on the surface caused by two successive discharges of opposite polarity.

When an impulse voltage is applied, discharges recorded when the film forms the negative surface of the cavity differ in shape and intensity from those recorded when the film is the positive surface. When the specimen forms the cathode, the initial discharge is recorded as a low-intensity glow, occurring over the whole surface of the cavity, and only just visible on the film; in subsequent tests with a new film, the discharge concentrates at one or two sites, indicating a permanent change of the cathode surface. When the films form the cathode, the discharge differs little in successive tests.

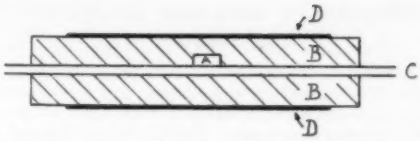

Fig. 1. Section of circular dielectric sample with inserted film. *A*, air-filled cavity; *B*, dielectric disks; *C*, film with sensitive surface adjacent to *A*; *D*, silver electrodes

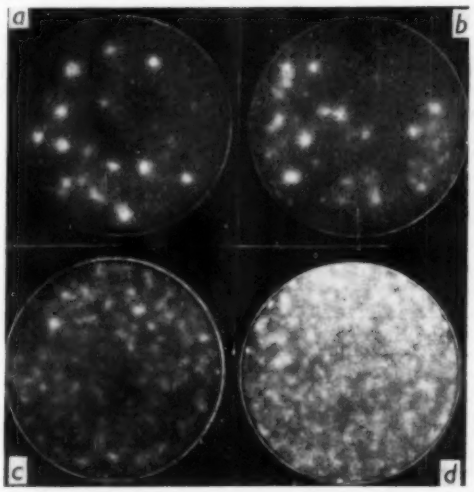

Fig. 2. Records of discharges in a cavity 0·5 cm. diameter and 0·03 cm. depth in polythene. (×7)
(*a*) 3 kV., 4 cycles. (*b*) 3 kV., 5 cycles. (*c*) 4·25 kV., 5 cycles. (*d*) 5 kV., 5 cycles

Previous authors believe that electrophotographs are caused by (possibly ultra-violet) light from the discharge[3, 4, 5]. The present results are consistent with this since, if the film is inserted with the sensitive surface distant from the cavity, only general exposure with no detail is always recorded. This suggests scattering of the emitted light in the cellulose acetate base.

Under other conditions a photographic effect has been attributed to ionic impacts[6].

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Townsend's Ionization Coefficient for Helium

ACCURATE experimental data are lacking for Townsend's ionization coefficient α/p for electrons drifting through helium, when the ratio X/p of electric field to pressure is small. As has been pointed out by Loeb[1], however, it is possible in this instance to calculate α/p from the relation[2]

$$\alpha/p = W^{-1}\int_{I}^{\infty} vf(V)P(V)dV,$$

where W is the drift velocity of the electrons, v the speed of an electron which has energy V in its random motion, $f(V)$ the energy distribution function in the random motion, I the ionization energy, and $P(V)$ the probability of ionization for an electron with energy V per unit random path at unit pressure, since the form of $f(V)$ has been determined with considerable accuracy by Smit[3].

X/p	3	4	5	6	8	10
W	17·5	23·5	30·2	37·5	52·0	68·0
α/p	7×10^{-3}	$1{\cdot}0\times10^{-2}$	$4{\cdot}2\times10^{-2}$	$7{\cdot}7\times10^{-2}$	$2{\cdot}4\times10^{-1}$	$4{\cdot}6\times10^{-1}$

The table contains a number of values of α/p computed in this way[4], for values of X/p between 3 and 10 volts/cm./(mm. mercury) together with the drift velocities (W) employed, in 10^5 cm./sec. The greatest uncertainty probably occurs in the values of W. The values adopted are close to those calculated by Smit[5], and are rather less than those given directly or by extrapolation from the experiments of Bradbury and Nielsen[6]. When the values of α/p are plotted on a logarithmic scale against log X/p, a line is obtained which can be extrapolated to somewhat below that giving the values of α/p found experimentally by Townsend and McCallum[7] for values of X/p greater than 12.

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Coating of Microscope Eyepiece Lenses

IN recent years the coating or 'blooming' of lenses has been widely practised and has proved a most effective means of eliminating undesirable reflexions. The process has been applied to the microscope, and the coating of objectives for use with normal incident illumination is quite common practice. It is not generally recognized, however, that in certain conditions the coating of eyepiece surfaces may be advantageous, and sweeping statements have appeared to the effect that no useful purpose is served by coating eyepiece lenses.

In any eyepiece multiple reflexion images are produced from the lens surfaces. Fig. 1 shows the

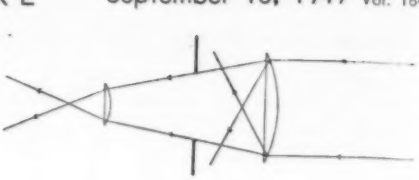

Fig. 1

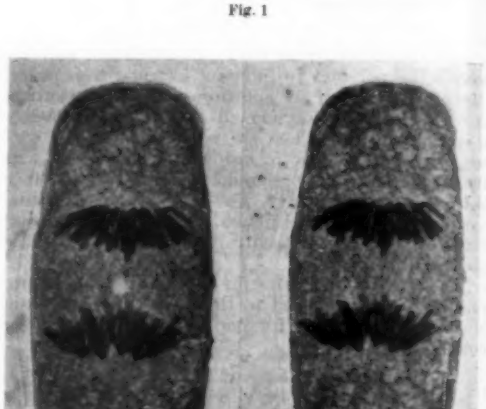

Fig 2

position of the first and brightest image produced by the field lens of a Huygenian eyepiece, and it will be seen that it is well behind the field stop. As this stop is at the principal focus of the eye lens, the image will therefore not be focused by the eye. In the widely used eyepiece, designed by Conrady, with variable separation between two corrected components (so that correction can be suited to different types of objective) the case is quite different. The reflexion image may at certain settings be brought into focus, and it appears in the centre of the field as a flare spot or a more or less sharp image of the light source. Visually this flare spot is not very noticeable unless the aperture of illumination is reduced; but it may be quite obvious when the eyepiece is used for photography. This is shown in Fig. 2*a* (a photograph of mitosis in a cell of *Libocedrus* taken with 2-mm. oil-immersion apochromatic objective and variable separation ×14 eyepiece); the flare spot appears in the centre of the photograph. It can, however, be quite easily eliminated by coating one or both surfaces of the field lens of the eyepiece. In practice, it is sufficient to coat one surface only, preferably the lower convex surface, as it is less likely to accumulate dust. It is important to insist on a good clean coating, as any flaws will appear as dark spots on the field. The so-called 'hard coating' is preferable as it is not so liable to damage. The photograph shown in Fig. 2*b* was taken under the same conditions as that shown in Fig. 2*a*, but a field lens with one surface coated has been substituted for the untreated component; it will be seen that the flare spot has been eliminated.

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Auroral Radiation in the 3,000-Megacycle Region

DURING the auroral display of January 24, short pulses of radiation were observed on the indicator of a radar set operating at a frequency of 3,000 megacycles. Since these pulses were observed even when the radar transmitter was off, it seemed probable that they were associated with the auroral display. Observations on twenty auroral displays since January 24 seem to confirm the auroral origin of these pulses.

The radar receiver had been equipped previously with an antenna designed to pick up radiation from an angle of about $6{\cdot}3 \times 10^{-2}$ spheradians. During the course of the investigation of the pulses, the following additions were made to the equipment. An electronic discriminating circuit was added to the receiver to indicate the presence of the pulses and to count the rate at which they were received. An auroral camera, modified so as to use 35-mm. film and to operate by remote control, was mounted beside the receiving antenna so that it moved with the antenna. With this equipment, the observer could detect the presence of pulses on the cathode ray tube, count the rate at which the pulses were being received, and photograph the region of the sky towards which the antenna was directed.

The pulses arrive in a random manner, occurring in bursts lasting only a small fraction of a second. Each pulse appears to be of one to five microseconds duration. Bursts of radiation in which the individual pulses appear to be separated by as little as ten milliseconds are observed; but the very short duration of the bursts makes difficult the accurate determination of this interval. The rate at which the bursts occur is variable between wide limits and seems to depend both on the intensity of the display and on the type of aurora. The pulses are more numerous with bright, active displays, exhibiting a definite structure. The types of aurora, arranged in order of increasing pulse activity, are as follow: glow, corona, homogeneous arc, flaming aurora, homogeneous band, ray arc, ray band and isolated ray. The auroral designations correspond to the ones used in the Photographic Atlas of Auroral Forms, International Geodetic and Geophysical Union, 1930.

The investigation is continuing with the view of determining quantitatively the pulse frequencies for different types and intensities of aurora, and also the possible mechanisms responsible for the observed pulses of radiation.

This work is supported financially by the Defence Research Board of Canada.

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A High-Intensity Light Source for High-speed Cinematography

HIGH-SPEED cinematography, that is, a camera operating at speeds up to 3,000 pictures per second, presents special lighting problems as compared with the more conventional speed of 24 frames per second normally used for ciné-film photography. The light intensity for a satisfactory exposure to be made at these high speeds is approximately proportional to the ratio of frames per second, and with an average object having a reflectivity of 10 per cent, the illumination required is about 10,000 foot-candles for a lens aperture of f 2·7. However, at higher speeds the total exposure-time seldom exceeds 3 seconds, and it is therefore possible to consider other means of obtaining these very high intensities than by ordinary methods.

One method that has been used is to fire off in rapid sequence a series of photo-flash bulbs of the chemical reaction type mounted on a rotating disk, so arranged that each bulb is fired at the focus of the reflector to produce a relatively long flash of light from a series of short high-intensity flashes.

It is not possible to increase the light output of a photo-flood lamp which has a high-temperature filament with a life of about 2 hr., as the tungsten filament is already running very close to the fusing point of the metal, and where heavy filaments are used there is an appreciable lag in reaching maximum brightness if they are subjected to short overload periods. Small carbon arcs do not respond to large variations in current, the arc becoming unstable in operation.

We have recently obtained very successful results by operating high-pressure mercury vapour lamps at considerable overloads for periods up to several seconds; for example, a lamp having a normal rating of 1 kW. and designed for D.C. operation may (with special electrodes) be overloaded to 10 kW. for a duration of 1 second, or 4 kW. for 3 sec. giving in a reflector 18 in. in diameter an average illumination of 500,000 foot-candles over a 10-in. diameter circle at a distance of 3 ft. A prototype model being designed will use a smaller mirror, and it is estimated that a maximum intensity of 250,000 foot-candles covering an area of 12 in. diameter at a distance of 3 ft. will be adequate for most purposes. Where higher intensities or modelling is required, two or more units may be synchronized.

When the lamp is operating at its steady continuous rating of 1 kW., sufficient illumination is provided for modelling purposes. During the exposure of a film, the lamp is triggered by the camera at the desired moment to its full power for a predetermined period, or at lower powers for longer durations. In this way the object being photographed is only subjected to the maximum light intensity and therefore heat radiation for a minimum of time.

Apart from the economical and simple method in which the required light intensity is obtained, the small 'modelling' light, the short period of flash and high efficiency of the mercury source, means that problems associated with the heating of the subject normally experienced under high light intensities is considerably reduced.

The mercury lamp may be colour-modified by the addition of cadmium metal, and the colour rendering at these high-pulse currents has enabled satisfactory high-speed films to be taken in colour. In the past, the use of colour film with its lower emulsion speed has not been considered readily practical due to the very high light intensities required. The colour-modified high-intensity compact source lamp thus furthers the use of high-speed cinematography in colour, and in monochrome a greater depth of focus is possible with smaller apertures. This method of obtaining high light intensities may be of importance apart from high-speed cinematography lighting.

In carrying out this work we have been greatly helped by the co-operation of the Research Laboratories of Messrs. Kodak, Ltd., Harrow.

E. J. G. Beeson

Research Laboratory,
British Thomson Houston Co., Ltd.,
Rugby. March 24.

Novel Methods of Producing Edge Tones with Liquids

We have recently observed what would appear to be two new methods of producing vortex edge tones (*a*) by allowing jets of water to impinge on perforated diaphragms and (*b*) by rotating perforated metallic disks under water.

(*a*) *Singing perforated diaphragms excited by liquid jets.* If a jet of water is played almost tangentially on a perforated diaphragm, then, under suitable conditions, the diaphragm is set into vibration and emits a loud audible note.

A convenient arrangement consists of a perforated disk of zinc, 0·3 mm. thick, soldered to one end of a brass tube of 5–10 centimetres diameter. The perforations can be 'close packed' 1·4 millimetres in diameter and with five holes to the centimetre. Water flowing through a rubber tube impinges on the diaphragm at a speed roughly controlled by pinching the tube and in a direction approximately tangential to the diaphragm.

The tones elicited vary somewhat with the position and angle of impact, but seem to bear no simple relation to the fundamental frequency of the loaded diaphragm. Adjustments are not critical and it is not necessary for the diaphragm to be perfectly flat. Occasionally two distinct notes are produced simultaneously. Using the dimensions stated above, the frequencies of the notes produced varied from below 500 to more than 1,200. Some reinforcement of the tones is obtained by using a resonating air column; but the resonance is usually not very pronounced.

(*b*) *Edge tones produced by rotation of a perforated disk immersed in a liquid.* When a thin solid flat metallic disk is rapidly rotated under water about an axis perpendicular to its plane, there is usually no production of audible sound. If, however, the disk is perforated with a ring of similar regularly distributed holes, then, at certain speeds of rotation, audible sounds characteristic of the speed can be heard with the aid of a submerged listening device.

The rotating disk does not behave as a siren, since the notes it produces are separated by silent intervals as the speed of rotation is varied. Usually the frequency of the emitted note is higher at high speeds of rotation, but occasionally the same note or even a lower note is produced as the speed is increased.

Suitable disks for producing these effects may be of brass or aluminium, 1 mm. thick, 10–15 cm. in diameter, perforated with holes of 3 mm. diameter. A single ring of 9 or 12 equally spaced holes or concentric rings of the same number of holes with ring diameters from 5–10 cm. have been found effective. For a given range of speeds more notes are produced with the multiple perforated ring system than with a single ring system.

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Equilibrium of Ionization in the Lower Atmosphere

One of the problems of atmospheric electricity is to account for the relation between the concentration of small ions near the ground and the number of Aitken condensation nuclei present. Small ions are lost in two ways, by recombination among themselves and by attachment to the Aitken nuclei. When nuclei are plentiful, the first process is relatively unimportant. If we assume a constant rate of production of q ion pairs/cm.³/sec., any straightforward type of theory predicts a relation of the type $q = nZ \times$ const., where n is the concentration of small ions of one sign and Z is the concentration of nuclei. So far is this from being true that formulæ of the type $q = \xi n Z^{1/2}$ [1] and $nZ^{1/3} =$ const.[2] have been proposed to fit the experimental results.

Some observations made near Dublin between January and July 1948 on the radium A content of atmospheric air, with simultaneous observations of nucleus content, may throw some light on the problem.

Nuclei/cm.³	<5,000	5,000–10,000	10,000–20,000	20,000–30,000	>30,000
Ra A atoms × 10^{-3}/cm.³	7·4	7·5	10·1	15·5	27·3
No. of observations	67	152	139	32	21

With increasing concentration of nuclei, there is a marked increase in radium A content. It seems clear that the conditions which favour the accumulation of one kind of body near the ground favour that of the other. According to Hess[3], about half the ionization at ground-level is due to the radioactive matter in the air. The position is that the rate of ion-production in any place where nuclei are plentiful is far from being constant, but increases with the increase of nuclei. Any simple form of equilibrium relation between n and Z is, therefore, not to be expected.

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High-Frequency Discharges Localized Along Tracks of Ionizing Particles

It has been found that an intense high-frequency electric field can produce visible discharges localized along the tracks of α-particles and β-particles passing through a gas.

A closed glass tube *A* provided with a thin mica window *B* was fitted into a wire gauze cylindrical wave-guide *C* which was excited in the $T\,E_{\cdot\,\cdot}$ mode by 1·4 μsec. pulses from a 60-kW. peak power 3,000-Mc./s. magnetron. The power delivered to this section could be varied, and standing waves were eliminated by matching the absorbing termination of the wave guide.

The photographs were obtained with an uncorrected condenser lens (f number ~0·6), and the tube was filled with neon saturated with iodine vapour at a total pressure of about 20 cm. mercury. In the

Fig. 1

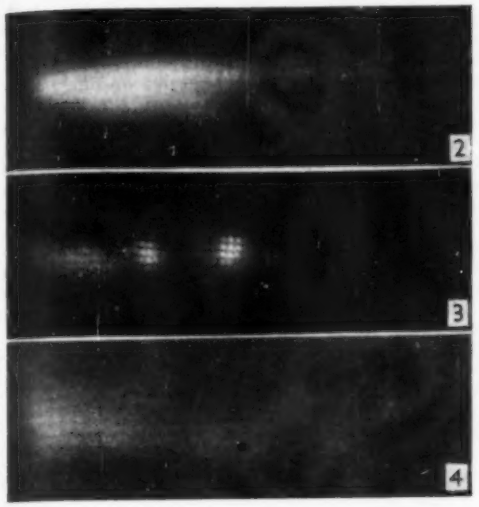

Fig. 2. Three α-particles

Fig. 3. A β-particle. When α-particles were stopped by an absorber placed between the source and the window, only such 'broken' flashes were observed

Fig. 4. Two β-particles

photographs the mica window B is situated just to the left of the flashes. These flashes are due to radiations from a radioactive source placed in front of the window at C. The wire mesh of the wave-guide shows up across the flashes. The distance between adjacent parallel wires is 0·1 in.

In Figs. 3 and 4 the photographs show the spread of the discharges in a plane parallel to the electric vector of the wave at the centre of the guide; the photograph in Fig. 2 was obtained from a direction perpendicular to that used for the other photographs.

Without the iodine vapour and using a repetition-rate as low as 100 pulses/sec., the power setting was critical, and occasionally the discharge carried over from one pulse to the next. When this occurred, the power had to be reduced below that necessary to maintain the pulsed discharge and then raised again to the working value.

It is likely that an increase in intensity of the flashes would be obtained if higher pressure gas-fillings and corresponding higher fields were used. With other modifications obtained by changing the frequency, type of wave-guide section, gas-chamber, and gas-filling, together with electronic and photo-electronic triggering circuits to switch the transmitter on and off, the device may be of use as a research tool in nuclear physics, as well as a means of investigating high-frequency discharges.

Details of this work will be published in the near future.

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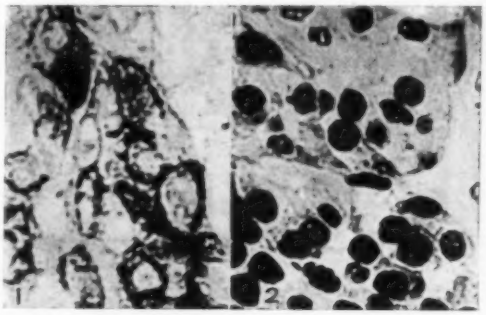
March 10.

Different Kinds of Acid Phosphatases in Various Cytological Structures of the Anterior Pituitary of the Guinea Pig

Investigations begun by one of us[1] have been continued by further examination on the basis of Gomori's method[2] and its modifications[3] of the acid phosphatases of the pituitary. As substrate, α- and β-glycerophosphate was used, and for reasons emphasized by Michælis[4], the mixtures were stabilized with the acetate-veronal buffer and adjusted with a glass electrode. The sections (thickness 4 μ), first treated with citrate buffer at pH 5·5, were subjected to reaction mixtures with the following pH values: 6·8, 6·6, 6·3, 6·0, 5·5, 5·0, 4·5, 4·2, 4·1, 4·0, 3·9 and 3·5. In critical ranges the intervals were made shorter. The incubation times were 30 min., 1 hr., 2 hr., 24 hr., 48 hr. and 72 hr. Eighteen pituitaries of female and male guinea pigs were investigated. The process of diffusion as a possible source of errors was observed to be smaller than in the case of alkaline phosphatase. Some inconstancy of reaction already noticed and discussed by several previous authors[5] did not interfere with the principal differences of localization and relative amounts of enzymes at various pH.

Characteristic reactions were observed for different ranges of acidity. When the reaction took place at pH 6·8–6·0 (optimum 6·6), the phosphatase was found to be localized mainly in and on the cell surfaces and in the intercellular spaces and walls of blood vessels adjacent to secretory cells rich in phosphatase. Less frequently, phosphatase was also found in the interior of the cytoplasm, sometimes in unipolar localization but mostly within the whole cell up to the nuclear surface. No phosphatase, or at most a trace, was found inside the nuclear membranes of normal cells. The precipitates appeared in the form of coarse droplets or layers strikingly different from fine granules formed by the action of alkaline phosphatase. In degenerating nuclei a strong diffuse reaction was found at the prevailing pH.

In a pH range from 6·0 (or even from 6·3) to 4·1 (optimum 5·5–5·0), no one phosphatase could be demonstrated on and outside cell surfaces. The cytoplasm did not react. The interior of



Photomicrographs of frontal sections of the centro-ventral region of the anterior pituitary of male guinea pig (× 800)

Fig. 1. Coarse precipitates on cell surfaces and in the cytoplasm (left-hand top corner), formed by the action of acid phosphatase during 72 hr. incubation at pH 6·8. The inside of the nuclei is almost without reaction

Fig. 2. Completely dark or partially granulated nuclei of secretory and connective tissue cells after incubation for 72 hr. at pH 5·5. Cytoplasm (except of some pycnotic cells) and cell surfaces without precipitates. The relative dense net of connective tissue fibres is light grey

the nuclei showed a very strong reaction, however. After twenty-four hours of incubation a great part of the nuclei was completely dark, whereas the other nuclei were filled to varying degrees with dark particles. After seventy-two hours the nuclear reaction reached its maximum intensity and extension. At this time, also, the connective tissue often could be seen as a dark network penetrating the sections. At *p*H 5·0–4·1 (optimum *c.* 4·3) the connective tissue was visible after only twenty-four hours incubation; but its appearance was somewhat different and it was partly concealed by another reaction, namely, that in this range of *p*H the cytoplasm of a large number of cells again showed the presence of phosphatase. Yet the droplets of precipitate were less coarse than those at *p*H 6·6. Simultaneously the nuclei began to lose their granulations and to appear to be diffusely filled with sulphide. The precipitates were light-brown at *p*H 6·6, reddish-black at 5·5–5·0 and yellowish at 4·3. All phosphatases were inhibited by sodium fluoride, and different concentrations of fluoride were required to inhibit the reactions at different *p*H.

The present classifications of phosphomonoesterases[7] show that enzymes from different sources have different *p*H optima in the acid range. But it is still an open question whether several independent acid phosphatases exist, particularly in the same tissue and simultaneously. We suggest that the pictures we obtain of the chief structures of secretory cells from different male and female individuals of various ages and functions are so typical and constant for each structure at each *p*H that they may best be explained by supposing the co-existence of several acid phosphatases in different cytological structures of the same cell. The functional variations of intracellular *p*H as a regulator of cellular activities[8] may have a special significance in pituitary secretory cells.

We believe that there are at least two different acid phosphatases, of *p*H 6·6 and of *p*H 5·5–5·0, co-existing in the anterior pituitary of the guinea pig. Judging by the pictures they produce, they are supplementary in function. The *p*H 5·5–5·0 acid phosphatase is a typical nuclear enzyme, whereas that of *p*H 6·6 is an enzyme of cytoplasm and of cell surfaces. The existence of a third different kind of acid enzyme (optimum *p*H *c.* 4·3), observed both in the nuclei and in the cytoplasm (perhaps diffused out of nuclei), is questionable. All the cellular structures mentioned can maintain simultaneously both one of the acid phosphatases and the alkaline phosphatase[1]. In this connexion it should be remembered that, from the earlier work of Dempsey and Deane[9], alkaline and acid enzymes may co-exist in the same cellular location in the duodenum of the mouse.

For the time being we shall refrain from drawing conclusions as to whether the acid phosphatases of anterior pituitary of the guinea pig are identical with those of types IV, II and III of existing classifications. Should this be so, their *p*H optima in the guinea pig pituitaries are shifted to the alkaline side. It was also surprising that the erythrocytes reacted at *p*H 6·8–5·5 weakly and irregularly, but strongly at *p*H 5·0–4·0.

Our investigations are being continued with the view of determining the distribution of different acid phosphatases in various types of secretory cells. Apparently the nuclei of all three cell-types are rich in acid phosphatases though in very variable degrees. However, only the cytoplasm and cell surfaces of typical acidophilic cells appear to contain greater amounts of these enzymes. This relation recalls the difference previously established[1] in the alkaline phosphatase content of acidophile and basophile cells. It may be assumed that the protein-producing acidophile secretory cell is very rich in different kinds of phosphatases, whereas the glucoprotein-producing basophile cell is relatively poorer.

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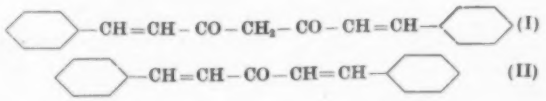
Antibacterial Action of Curcumin and Related Compounds

INVESTIGATIONS by A. R. Todd[1], H. Rinderknecht[2], W. B. Geiger[3] and others have shown that many unsaturated ketones with the grouping —C=C—CO—, also present in a number of naturally occurring antibiotics, possess antibacterial action. In our studies on unsaturated ketones, we found that chalkone, flavanone, flavone and some of their derivatives, for example, buteine (2,4,3′,4′-tetrahydroxychalkone) a substance of vegetable origin, showed a marked



Compound	Dilution giving total inhibition of growth			
	Staph. aureus	*Salm. paratyphi*	*Trichophyton gypseum*	*Mycobact. tuberculosis*
I	< 1 : 20,000	< 1 : 20,000	1 : 10,000	1 : 10,000
4,4′-Dihydroxy-3,3′-dimethoxy-I (Curcumin)	1 : 20,000	< 1 : 5,000	1 : 40,000	1 : 40,000
II	1 : 20,000	< 1 : 10,000	1 : 320,000	1 : 160,000
4,4′-Dihydroxy-3,3′-dimethoxy-II	1 : 20,000	< 1 : 5,000	1 : 40,000	1 : 40,000
4,4′-Dihydroxy-II	1 : 20,000	< 1 : 10,000	1 : 10,000	1 : 80,000
2,2′-Dihydroxy-II	1 : 80,000	1 : 40,000	1 : 40,000	1 : 80,000
2,2′-Dihydroxy-5,5′-dibromo-II	1 : 640,000	1 : 20,000	1 : 320,000	1 : 160,000

inhibition of the growth of *Staph. aureus*. Also extracts of plants containing flavanones, flavones or flavonoles were found to be bacteriostatic[4]. Furthermore, we have prepared a number of synthetic chalkones of which some compounds suppressed the growth at high dilutions.

We have now investigated curcumin and compounds of similar structure. The test methods used were the same as in previous papers (*Staph. aureus* and *Salm. paratyphi*[5], *Trichophyton gypseum*[6]). The method for tuberculostatic studies will be published elsewhere.

In the accompanying table are given the results of tests on curcumin and some similar compounds.

Because the preparation of hydroxy derivatives of distyroylmethane is very difficult, and since we found that 4,4′-dihydroxy-3,3′-dimethoxydibenzalacetone has the same antimicrobial action as curcumin, we choose for our investigation some derivatives of dibenzalacetone which could be prepared in a simple manner from substituted aldehydes and acetone.

From the results presented in the table, it will be seen that curcumin has a marked activity against all four test organisms, whereas the distyroylmethane has but little activity. 2,2′-Dihydroxybenzalacetone and its 5,5′-dibromo derivative were highly active against *Staph. aureus*. With *Trichophyton gypseum* and *Mycobact. tuberculosis* as test organisms, these two compounds and also dibenzalacetone exhibited a remarkable inhibition of growth. All the unsaturated ketones are, in general, less active against the Gram-negative *Salmonella paratyphi*.

Experiments with some other unsaturated ketones are in progress, the result of which will be published later.

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Influence of Thyroxine on Hexokinase, Succinoxidase and Choline Oxidase

A number of workers have reported that the administration of either thyroxine or thyroid powder to a number of species results in significant changes in the activity of various tissue enzymes. Thus the D-amino-acid oxidase[1] and succinoxidase and cytochrome oxidase[2] activity of liver appears to be enhanced in hyperthyroid rats; the activity of rat serum pseudo-choline-esterase is markedly decreased following thyroxine administration[3], while the activity of rat liver arginase and acid phosphatase appears to be uninfluenced by thyroxine[4]. We have recently investigated the influence of thyroxine administration on the activity of certain enzymes in the liver and skeletal muscle of adult, male hooded rats. In view of the fact that thyroxine was administered over a period of some days prior to measuring the enzyme activities, the paired feeding technique was employed in order to eliminate alteration in the food intake of the thyroxine-treated animals as a factor responsible for any changes observed. In each series of experiments the animals were pair-fed on a synthetic diet supplemented with vitamins.

The mean hexokinase activity of aqueous extracts of leg muscle, prepared by methods similar to those described by Colowick, Cori and Slein[5], was significantly enhanced in thyroxine-treated rats. Table 1 summarizes the results of these experiments.

Table 1

Group	Number of animals	Hexokinase activity (μgm. glucose utilized per 320 mgm. (wet weight) tissue in 10 min.)
Controls	6	278 ± 14†
Thyroxine injected (total of 5 mgm. over a period of seven days)	6	464 ± 35
		Statistical analysis: $t = 4{\cdot}369$, $P < 0{\cdot}01$

Enzyme activity determined in open test tubes at 28·0° C. Veronal-acetate buffer, 0·028 *M*; $MgCl_2$, 0·0085 *M*; NaF, 0·056 *M*; adenosine triphosphate 0·042 *M*; glucose, 0·02 *M* in total volume of 2·35 ml. Glucose estimated by the method of Nelson (ref. 6).
† Standard error of mean.

In confirmation of the report of Tipton and Nixon[7], it was found that thyroxine administration led to a significant increase in the succinoxidase activity of rat liver, as can be seen from the experiments summarized in Table 2.

Table 2

Group	Number of animals	Liver succinoxidase activity	
		Qo_2	Qo_2 × total dry weight of liver (gm.), computed in terms of a 250-gm. rat
Controls	6	54·2 ± 1·6	110·9 ± 7·3
Thyroxine injected (total of 1·2 mgm. over a period of six days)	6	80·4 ± 3·6	154·3 ± 6·5
		Statistical analysis	
		t 6·77, $P < 0{\cdot}001$	4·56, $< 0{\cdot}01$

The choline oxidase activity of rat liver, however, appeared to be unaltered in thyroxine-treated rats. The enzyme activity was determined by measuring the rate of oxygen uptake of aqueous homogenates in the presence of choline chloride and correcting for the respiration in the absence of added substrate (neither of which was significantly affected by the addition of cytochrome *c* to a final concentration of $1{\cdot}3 \times 10^{-5}$ *M*). The results of these experiments are shown in Table 3.

Table 3

Group	Number of animals	Liver choline oxidase activity (μl oxygen consumed per 166 mgm. (wet weight) of tissue in 20 minutes, corrected for endogenous respiration)
Controls	6	73·1 ± 3·2
Thyroxine injected (total of 3 mgm. over a period of five days)	6	72·8 ± 5·9

Estimations carried out manometrically in air at 37·0° C., *p*H 7·8. Phosphate, 0·06 *M*; choline, 0·014 *M*.

The *in vitro* addition of either L- or DL-thyroxine (1×10^{-6} to 1×10^{-4} *M*) had no significant immediate influence on the activity of rat-muscle hexokinase, liver-choline oxidase and succinoxidase,

Similarly, thyroglobulin (0·8–4·0 mgm. per ml.) and iodinated casein (2·0 mgm. per ml.) were devoid of significant *in vitro* influence on the activity of these enzymes.

The enhanced muscle hexokinase activity of the thyroxine-treated animals can, perhaps, be correlated with the increased rate of carbohydrate metabolism in experimental hyperthyroidism. The lack of influence of thyroxine administration on liver-choline oxidase emphasizes that the thyroid hormone does not affect all the respiratory enzymes of rat liver. Furthermore, it seems that although the activity of both muscle hexokinase and liver succinoxidase of thyroxine-treated rats is significantly enhanced, similar changes cannot be simulated by the *in vitro* addition of either thyroxine or the thyroxine-containing proteins thyroglobulin and iodinated casein to preparations of these enzymes isolated from normal animals.

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[1] Klein, J. R., *J. Biol. Chem.*, **128**, 659 (1939).
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Availability of the Magnesium of Grass to the Ruminant

Hitherto, it has, apparently, been assumed that the magnesium of chlorophyll is split off under the action of the gastric juice and thus becomes available for absorption. I have been able to find no experimental evidence to verify this assumption.

Sterile grass powder was incubated with a suspension of ruminal organisms, obtained from the sheep or ox, under conditions reproducing, so far as possible, those in the rumen. After 'ruminal' digestion, which was allowed to proceed for 36–72 hr., the reaction mixture was brought to *p*H 2 by addition of 0·02 *N* hydrochloric acid to simulate conditions in the abomasum, and incubated for a further three to twenty-four hours. The ultrafilterable magnesium present at the end of the 'ruminal' and 'abomasal' phases was estimated.

The results obtained are summarized in the accompanying table:

*p*H of 'ruminal' contents	Number of experiments	Ultrafilterable magnesium (as per cent total magnesium present)	
		Ruminal organisms present	Ruminal organisms absent
After 'ruminal' digestion:			
6·9	4	85·0 ± 0·9	80·0 ± 3·6
7·8	1	Nil	Nil
8·9	4	Nil	Nil
After 'abomasal' digestion			
6·9	5	96·0 ± 1·2	90·0 ± 4·1
7·8	1	100·5	93
8·9	4	93·5 ± 1·6	91·5 ± 1·7

By applying the *t* test to the results obtained with and without ruminal organisms at all values of 'ruminal' *p*H, it is found that *P* lies between 0·05 and 0·02. Assuming that the '0·05-level of significance' is satisfactory as a criterion, it is evident that ruminal organisms play a significant part in the liberation of magnesium from plant cells.

The absence of free magnesium in the alkaline 'rumen' is probably due to the formation of insoluble salts, from which it is liberated by the action of the abomasal hydrochloric acid.

I have to thank the Director of Veterinary Services, Nigeria, for permission to publish this note.

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Persistence of Pyrethrins and Gamma Isomer of Benzene Hexachloride

It is well known that both light and air rapidly destroy the pyrethrins, therefore to obtain a true picture of the relative persistence of pyrethrins and the gamma isomer of benzene hexachloride as a protector of grain, the scales should not be weighted against the pyrethrins by exposing the treated grain in open jars, as is done in Bovingdon's experiment[1]. Furthermore, the quantities of pyrethrins used in his experiment are very much less than those in mine[2]. Bovingdon's applications, in the terms of pyrethrum powder, containing 1·3 per cent pyrethrins, work out at 1¼, 2½, 5 and 6¼ oz. of the powder to a 200-lb. bag of grain.

The persistence of the toxic effect of the pyrethrum powder in my experiments was most unexpected; but possibly this is due to the fact that the pyrethrum powder was in the dark, and the oxygen content of the atmosphere within the bags, owing to respiration of the grain, was lower than the normal atmosphere.

Although gamma hexachloride, at a concentration of 0·5 p.p.m., will kill *Sitophilus granarius* and *Sitophilus oryzæ*, even at double this concentration, it is non-effective against *Tribolium castaneum*. It is also not yet definitely known whether even at this low concentration there may not be definite toxic effects to mammals regularly taking grain treated with benzene hexachloride. Lehman reports that it is impossible to feed, in a single dose, a sufficient quantity of the beta isomer of benzene hexachloride to kill a rat, yet when fed over a long period, a concentration as low as 10 p.p.m. produced gross evidence of poisoning[3]. There has been no evidence of poisoning by pyrethrum or the pyrethrins.

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[1] Bovingdon, H. H. S., *Nature*, **163**, 731 (1949).
[2] Beckley, V. A., *Nature*, **162**, 737 (1948).
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In reply to the queries raised by Mr. Beckley, I should like to record that the experiments described in my original letter were carried out merely to compare the toxicity and persistence of pyrethrins and

gamma benzene hexachloride under similar conditions. The dusted wheat was contained in 2-oz. glass jars covered with organdie muslin and packed closely together in a wooden tray, 2½ in. deep. The experiment was conducted in a constant-temperature room having a small window facing north-east. Consequently, only very weak, diffuse light reached the dust scattered among the wheat grains.

Since the depth of the wheat in the jars was quite shallow, oxidation effects may have been of a higher order than that in the bags used by Beckley. Yet it is not likely that the oxygen content of the air within two or three inches of the surface of the bags, where insect infestation is usually high, would be much below that of the air outside.

Lehman's results with the beta isomer, quoted by Beckley, do not apply to the gamma isomer.

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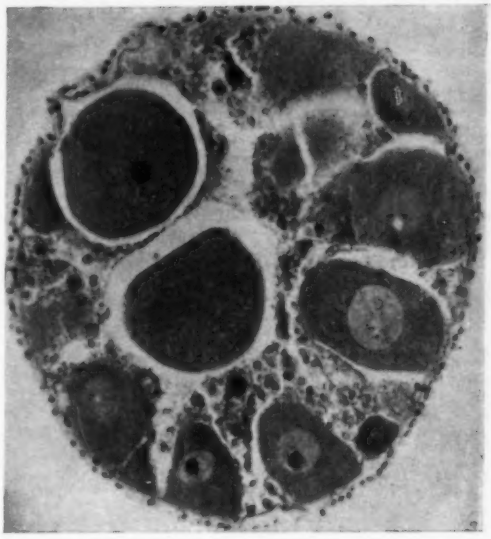
Trephocytes in *Arbacia punctulata* and their Role in Ovular Growth and in Respiration

Studies on tunicates, insects, annelids and the cœlenterate *Tubularia*[1,2] have revealed the presence of two main types of leucocytes in them: (*a*) agranular, amœboid phagocytes, and (*b*) granular, poorly or non-amœboid and non-phagocytic elements, for which I have proposed the term 'trephocytes'. In the organisms mentioned above, trephocytes frequently constitute 50–75 per cent of all leucocytes. Their inclusions are of a nutritive nature and are released into the blood, the tissues, or directly into other cells, a function referred to as 'trephocytosis'. Trephocytes are highly active in growth, and the study of trephocytosis proved instrumental in elucidating some of its manifestations and correlations.

Saint-Hilaire[3] came close to similar conceptions with respect to conditions in sea-urchins. He distinguished sharply between their agranular phagocytes and the non-phagocytic granulocytes. The latter, however, were not found to be involved in nutritive processes, and a search for a possible role in the gonads proved negative, leading him to the assumption that the granulocytes take up metabolic end products. Earlier, Cuénot[4] observed that certain granular leucocytes liberate their inclusions, presumably originating in the digestive tract, throughout the organism. He was unaware of the specific character of these elements, and later[5] abandoned his views as to the trophic nature of the granulocytes in favour of an excretory conception.

Our investigations on *Arbacia* have disclosed conditions similar to those found in other invertebrates studied. The trephocytes of this species also show characteristics generally found in these elements: large size; a small non-nucleolated nucleus, fragmented, pycnotic or missing in mature cells; and nutritive inclusions in the cytoplasm. These inclusions are liberated throughout the organism, the cell usually disintegrating during this process. No evidence was forthcoming indicating that the trephocytes are modified phagocytes, as claimed by Cuénot[4] and others. During the period of investigation (June, July), the trephocytes in the perivisceral fluid were found to make up slightly more than 50 per cent of the total. As in some organs they comprise the only leucocytes present, their actual number in the organism may be considerably higher. Depending on the colour of the inclusions, the living trephocytes appear as green, red or colourless variants. Several characteristics suggest that the green kind represent the original form.



Cross-section of the ovary showing the interovular spaces filled with disintegrated trephocytes. The spaces around some oocytes are due to shrinkage caused by fixation

Contrary to the observations of Saint-Hilaire, the ovaries were found to be packed with numerous red and colourless trephocytes, most of them in an advanced state of disintegration (see illustration). Suitable preparations reveal that the young oocytes take up and assimilate the cellular inclusions and fragments of this brei. The quantity of material taken up appears to be considerable, suggesting that much of the ovular growth is due to substances derived from the trephocytes.

The red pigment of the trephocytes, named echinochrome by MacMunn[6], has been claimed to be an oxygen carrier[5,7] or activator[8,9], a view denied for the pure substance by Tyler[10]. McClendon[11] found echinochrome in the test and eggs of *Arbacia punctulata*. Since the present study revealed that a considerable proportion of the material incorporated in the oocytes is derived from the red trephocytes, the possibility is not precluded that the echinochrome of the eggs is of the same origin.

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March 21.

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FORTHCOMING EVENTS

Wednesday, September 14

INSTITUTE OF PETROLEUM (joint meeting with the INSTITUTION OF FIRE ENGINEERS, at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. H. Burgoyne, Mr. L. L. Katan and Mr. J. F. Richardson: "The Application of Air-Foam to Oils Burning in Bulk"; Mr. J. H. Burgoyne, Mr. L. L. Katan and Mr. J. F. Richardson: "The Use of Solid Carbon Dioxide to Extinguish the Burning of Liquids"; Mr. E. Thornton: "Some Practical Aspects of the Application of Foam to Large Oil Tanks".

Thursday, September 15

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. E. H. Atkin: "Inter-City Transport Development on the Commonwealth Routes" (Fifth British Commonwealth and Empire Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AGRICULTURAL CHEMIST IN THE TOBACCO DIVISION, Department of Agriculture and Lands, Southern Rhodesia—The Secretary, High Commissioner's Office, Rhodesia House, 429 Strand, London, W.C.2 (September 20).

ASSISTANT EXPERIMENTAL OFFICER IN THE ENTOMOLOGY DEPARTMENT, for work on Soil Insects—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (September 24).

LECTURER or ASSISTANT LECTURER IN PSYCHOLOGY, with special interests in Experimental Psychology—The Registrar, The University, Manchester 13 (September 26).

LECTURER IN AGRICULTURE and FARM DIRECTOR—The Registrar, The University, Leeds 2 (September 30).

BIOCHEMIST—The Chief Administrative Officer, Reading and District Hospital Management Committee, 3 Craven Road, Reading, endorsed 'Appointment of Biochemist' (September 30).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS, with special qualifications in Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (September 30).

LECTURER IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (September 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY—The Registrar, University College, Cathays Park, Cardiff (October 1).

RADIOCHEMICAL INSPECTOR to the Ministry of Health—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2754 (October 12).

LECTURER or a READER to take charge of the DEPARTMENT OF GEOGRAPHY—The Registrar, Trinity College, Dublin (October 20).

SENIOR LECTURER IN STATISTICS in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (December 31).

WORKS CHEMISTS AND PHYSICISTS (at Windscale Works, Sellafield, Cumberland) for supervisory duties connected with the operation of a large factory consisting of nuclear piles and associated chemical plant, TECHNICAL ASSISTANTS (at Springfields Factory, Preston, and Windscale Works) for investigating and preparing reports on technical problems connected with the production and development work in atomic factories, and JUNIOR CHEMISTS AND PHYSICISTS (at Windscale Works) for supervising work involving chemistry and/or applied physics—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

LABORATORY TECHNICIANS (2) IN THE CHEMICAL AND BIOLOGICAL DEPARTMENTS—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

HEAD OF THE NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

LABORATORY ASSISTANTS (junior)—The Science Department, St. Paul's School, West Kensington, London, W.14.

ELECTRICAL ENGINEER or PHYSICIST, for research and development work on the application of electronic methods to mechanical engineering problems—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

SPECTROGRAPHER to take charge of spectrography section of Pedology Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

DIRECTOR OF THE EAST AFRICAN SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION—The Under-Secretary of State, Colonial Office, Research Department, Great Smith Street, London, S.W.1.

GEOLOGIST, a GEOPHYSICIST, and an ASSISTANT DRILLING ENGINEER, in the Public Works Department, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed with the appropriate reference.

CHEMIST TO THE DEPARTMENT OF CLINICAL ENDOCRINOLOGY, to be responsible for chemical hormone estimations in co-ordination with a BIOLOGIST carrying out animal assays—The Secretary, Queen Elizabeth Hospital, Edgbaston, Birmingham 15.

DIRECTOR OF LAND RECLAMATION, West Punjab Irrigation Branch—The High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Commission on the Press, 1947–1949. Report. (Cmd. 7700.) Pp. v+363. (London: H.M. Stationery Office, 1949.) 6*s.* net. [147

Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasurer, in the period from 1st April, 1948, to 31st March, 1949. Pp. 56. (London: H.M. Stationery Office, 1949.) 1*s.* net. [197

The National Health Service. Pp. 36. (London: H.M. Stationery Office, 1949.) 6*d.* net. [257

British Iron and Steel Research Association. Annual Report of Council, 1948. Pp. 100. (London: British Iron and Steel Research Association, 1949.) [277

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Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1939. Pp. v+114. (London: H.M. Stationery Office, 1949.) 2*s.* 6*d.* net. [48

Handbooks for the Identification of British Insects. Vol. 1, Part 5: Dermaptera and Orthoptera. By W. D. Hincks. Pp. 20. 3*s.* 6*d.* Vol. 1, Part 10: Odonata. By Lt.-Col. F. C. Fraser. Pp. 48. 7*s.* 6*d.* Vol. 9, Part 1: Diptera, i. Introduction and Key to Families. By H. Oldroyd. Pp. 49. 7*s.* 6*d.* (London: Royal Entomological Society of London, 1949.) [48

Other Countries

International Health Bulletin. (Quarterly.) Vol. 1, No. 1, January-March 1949. Pp. 40. (Geneva: League of Red Cross Societies, 1949.) Annual subscription, 6 Swiss francs; 1.50 dollars. [76

Council of Scientific and Industrial Research. New Zealand Journal of Science and Technology: Index to Volumes 1–25. Compiled by V. J. Wilson; with a Short History of the Journal by Loris H. Webley. Pp. x+226. (Wellington: Government Printer, 1948.) [48

Bulletin of the American Museum of Natural History. Vol. 93, Article 7: The Influence of Light and Darkness on Thyroid and Pituitary Activity of the Characin *Astyanax mexicanus* and its Cave Derivatives. By Priscilla Rasquin. Pp. 497–532+plates 20–25. (New York: American Museum of Natural History, 1949.) 75 cents. [48

Phyton: Annales rei botanicae. Vol. 1, Fasc. 1. Pp. 104. Vol. 1, Fasc. 2–4. Pp. 105–328. (Horn, N.Ö.: Verlaf Ferdinand Berger, 1948–1949.) [48

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Council for Scientific and Industrial Research. Aeronautical Research Report ACA–42: Observation of the Lubricating Oil Film between Piston Ring and Cylinder of a Running Engine—the Effects of Lubricant Properties and Additives. By R. L. Brooks and M. L. Atkin. Pp. 13. (Melbourne: Government Printer, 1948.) [48

Annals of the New York Academy of Sciences. Vol. 51, Art. 5: Antibiotics derived from *Bacillus polymyxa*. By P. H. Long, C. M. Alverson, M. J. Baker, P. H. Bell, R. G. Benedict, E. A. Bliss, J. F. Bone, R. Broschard, G. Brownlee, M. S. Bryer, S. R. M. Bushby, B. N. Carle, J. R. Catch, C. A. Chandler, A. C. Dornbush, G. M. Eisenberg, J. P. English, C. E. Fellows, R. C. Gore, K. S. Howard, E. R. Jackson, T. S. G. Jones, G. Krupka, S. Kushner, C. L. Larson, P. Little, E. M. Petersen, J. N. Porter, E. T. Reese, M. M. Rogers, E. B. Schoenbach, R. G. Shepherd, E. I. Short, P. G. Stansly, F. H. Stodola, Y. SubbaRow, A. E. Verder, H. J. White, S. Wilkinson, R. Winterbottom and J. S. Zellat. Pp. 853–1,000. (New York: New York Academy of Sciences, 1949.) 2.25 dollars. [48

Catalogues

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VHF Multi-Channel Communication. (Ref. SL. 101.) Pp. 4. Aircraft Radio Maintenance Simplified: Aircraft Equipment Tester Type *OA*. 216 for AD.97/108/7092 Aircraft Radio Apparatus. (Ref. SL. 301.) Pp. 8. 3-Kilowatt MF Beacon Type *WB*. 8 for Aeronautical Services. (Ref. SL. 302.) Pp. 4. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1949.)

A Catalogue of Books Offered for Sale. (No. 668.) Pp. 76. (London: Bernard Quaritch, Ltd., 1949.)

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